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Enlarged view of the left Membrana tympani
as seen through the speculum.

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HANDBOOK

OF

DISEASES OF THE EAR

FOR THE USE OF

STUDENTS AND PRACTITIONERS

BY

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WITH ILLUSTRATIONS.

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PREFACE.

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My object in writing this Handbook has been, not to give an exhaustive treatise on Otology, or even a digest of the many excellent works which are already published, but to present to my readers a practical manual which shall help them to recognise the various pathological lesions of the ear, to diagnose the different diseases, and to discriminate in the matters of treatment and prognosis.

As far as possible I have endeavoured to avoid controversial points, and to give simply the results of my own observation and practice. In thus, to a certain extent, limiting the subject I have been compelled to pass by somewhat cursorily those operative modes of treatment which have proved less successful in my hands, although I am well aware that some of them are advocated by distinguished aural surgeons for whose opinions I have the greatest respect.

In the preparation of this Handbook I have received much kindly assistance from several of my confrères, to

whom I desire here to tender my hearty thanks; and among these I should like especially to acknowledge my gratitude to Mr. Cresswell Baber for his many thoughtful and valuable suggestions, to Professor Burckhardt-Merian for the original drawing from one of his Eustachian tube preparations, and to Mr. Arthur Kinsey for help in the chapter on the Education of Deaf-mutes.

URBAN PRITCHARD.

3 George Street, Hanover Square, W.
July, 1886.

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DISEASES OF THE EAR.

INTRODUCTION.

THE auditory apparatus is concerned with two entirely distinct functions, *hearing* and *equilibration;* and disease or lesions of any of its parts will affect either the one or the other, or both. It is the former, however, which is the more frequently impaired, for the simple reason that whereas almost the whole of the apparatus is devoted to the function of hearing, only a very small portion is taken up with that of equilibration.

The most common symptom of diseases of the ear is deafness, partial or complete; or, in other words, *diminution* or *loss* of hearing power; and next to that in frequency is tinnitus (noises in the ear) which may be described as *disturbance* of hearing power.

Before entering into a description of the various forms of disease, it will be necessary to consider the anatomy and physiology of the various parts of this auditory apparatus, although it does not come within the scope of this hand-book to enter into all minute particulars. We will, therefore, content ourselves with giving a general description only, with especial regard to points of pathological importance, and refer our readers to Politzer's *Diseases of the Ear*, Quain's *Anatomy* and Retzius' *Das Gehörorgan der Wirbel Thiere* for a more detailed account.

The human auditory apparatus may be most con-

veniently divided, for our present purpose, into two parts:—

1. *The conducting apparatus.* Consisting of the external ear (auricle and meatus) and the middle ear (tympanum, Eustachian tube and mastoid process).

2. *The perceptive apparatus.* This, the essential portion, is made up of the internal ear or labyrinth (containing the nerve endings); the auditory nerve or portio mollis of the 7th cranial nerve; and the auditory centre, which is that part of the brain from which the nerve takes its origin.

The perceptive apparatus, although the more important part of the whole, would be of but little use without the conducting portion, for the simple reason that the nerve-endings are bathed in fluid; therefore sound waves passing from the gaseous medium (the atmosphere) to the fluid one, would be almost entirely reflected and lost unless there were some means whereby they might be picked up and transmitted to the epilymph. This duty is performed by the membrana tympani and the chain of ossicles, the essential parts of the conducting apparatus.

Equilibration.—The posterior portion of the internal ear or labyrinth, which comprises the semicircular canals and utricle, is devoted to the second and minor function of the organ, equilibration, or the sense of motion and equilibrium. The nerve fibres of this posterior portion form part of the portio mollis and have their centres in the cerebellum. Disturbance of any of these parts gives rise to those peculiar phenomena known as auditory vertigo or Ménière's symptoms.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE EAR.

THE CONDUCTING APPARATUS, as already stated, consists of:—

1. External ear. Auricle; external meatus.
2. Middle ear. Tympanum and contents; Eustachian tube; mastoid process.

For pathological purposes the whole conducting apparatus may be considered as a tube leading from the side of the head to the pharynx, but divided into two *culs de sac* by the membrana tympani; the outer one (the external ear) lined with dermis, continuous with the skin, the inner (middle ear) lined with mucous membrane and continuous with the pharynx.

It must be borne in mind that this tube passes through the bones of the skull and is, in several places, only separated from the cranial cavity by a thin layer of bone; hence the danger of extension of ear disease to the brain.

The External Ear.—The external ear, the outer portion of this tube, consists of the auricle and the external meatus.

The auricle (fig. 3), which may be likened in form to a flattened or crumpled up funnel, is made up of a skeleton of elastic cartilage covered by skin. The elasticity of this cartilage is an important point, for if the auricle had a bony framework, or even one of hyaline cartilage, it would, from its exposed position, be very liable

to fracture. The skin is closely adherent to the anterior surface of the cartilage, but on its posterior side it is somewhat loosely attached by means of areolar tissue.

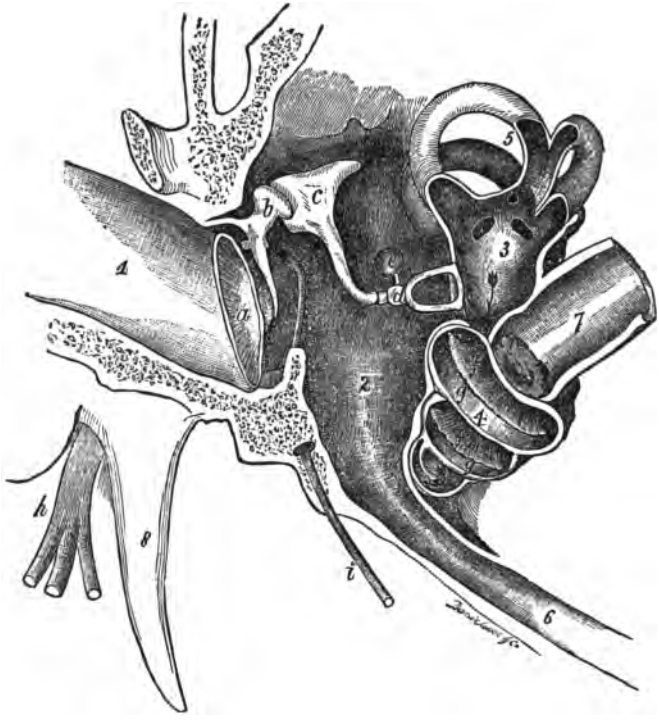

FIG. 1.—A diagrammatic view of the auditory apparatus. 1. External meatus. 2. Tympanic cavity. 3. Vestibule. 4. Cochlea. 5. Semi-circular canals. 6. Eustachian tube. 7. Internal meatus. 8. Styloid process. *a.* Membrana tympani; *b.* Malleus; *c.* Incus; *d.* Stapes; *e.* Pyramid containing stapedius muscle; *f.* Scala tympani; *g.* Scala vestibuli; *h.* Portio dura; *i.* Chorda tympani.

It will be seen, when we come to discuss the treatment of hæmorrhage and hæmatoma that this close adherence of the skin to the anterior surface of the carti-

lage is a point which must be taken into consideration by the surgeon.

The lower portion of the auricle (the lobe) is destitute of cartilage, and is made up of loose areolar tissue

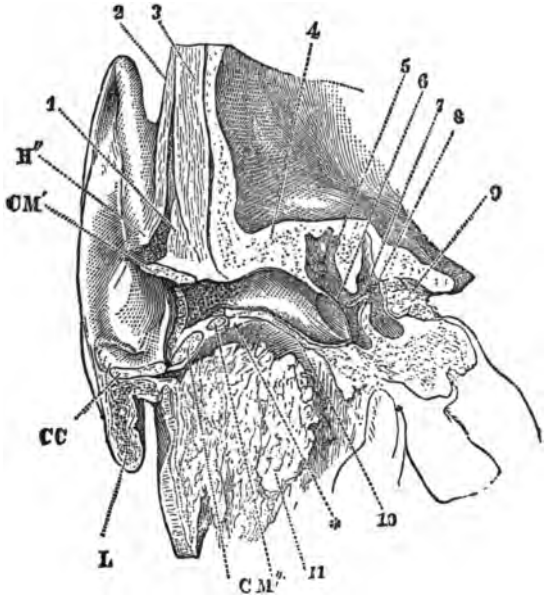

FIG. 2.—Section through external meatus, tympanum and internal ear, showing the actual form and relations of the parts, (after Henle). CC. Cartilage of auricle Cartilaginous meatus, CM'. roof, CM''. floor. H''. Spine of helix. L. Lobe of auricle. * Fibrous border of osseous meatus. 1. Epicranius temporalis muscle. 2. Levator auricularis. 3. Temporal muscle. 4. Roof of osseous meatus. 5. Cavity of the tympanum. 6. Membrana tympani. 7. Stapes. 8. Vestibule. 9. Internal meatus and acoustic nerve. 10. Floor of osseous meatus. 11. Parotid gland.

and fat between the two layers of cutis. This absence of cartilage makes it possible for the part to be pierced for earrings with impunity, which would not be the case if the perforation had to be made through cartilage.

The skin covering the lobe and the inner surface of the concha is freely supplied with sebaceous glands; these are liable to be converted into sebaceous cysts.

The tragus (the prominence in front of the meatus) is covered on its posterior surface with a tuft of hairs. These hairs occasionally help to form accumulations which obstruct the meatus.

FIG. 3.—The Auricle.
a. Helix; *b.* fossa of helix; *c.* anti-helix; *d.* fossa of anti-helix; *e.* tragus; *f.* anti-tragus; *g.* concha leading to the external meatus; *h.* lobe.

The cartilage of the auricle is continuous with that forming the outer portion of the meatus, and is attached to the temporal bone by fibrous ligaments. There are numerous small ligaments and bands of muscular fibres connected with the cartilaginous skeleton, but these are of no pathological interest and therefore do not need further mention.

External meatus.—The external auditory meatus is a tube leading from the auricle to the membrana tympani, varying somewhat in length, but averaging about one inch. The outer third is cartilaginous, the inner two thirds are osseous. The meatus is somewhat curved, and indeed may be said to describe a double curve, so as to be higher in the middle. This curvature is chiefly in the cartilaginous portion and may be straightened by traction of the auricle upwards and backwards. The direction of the meatus is inwards; first a little upwards and backwards, and then forwards and slightly downwards, varying in different individuals. The calibre of the meatus varies somewhat. It is largest in the cartilaginous portion, diminishes in the first part of the osseous meatus and then enlarges again. The narrowest part, *isthmus*, is about midway in the meatus, and is chiefly due to elevation of the floor. In some cases, especially in patients of a gouty diathesis, this elevation is greatly increased. Foreign bodies are apt to lodge beyond the isthmus, and in consequence may be difficult of removal.

The cartilaginous skeleton is continuous with that of the auricle; it has an incomplete tubular form, the tube being completed by fibrous tissue. The floor presents two transverse fissures—fissures of Santorini—which are filled in with fibrous tissue and serve to give greater mobility to the auricle. This cartilaginous tube is attached to the rough margin of the osseous part by fibrous tissue.

The osseous portion is formed chiefly of a curved plate of bone, the vaginal process, developed from the separate tympanic bone of the fœtus. This curved plate is not complete at its upper part near the tympanum, the space being filled with fibrous tissue; and

this deficiency in the bony wall allows suppurative inflammation to pass between the vaginal and mastoid processes, so as to appear as a superficial mastoid abscess, to be described later on. At the end of the bony meatus is a shallow groove incomplete at its upper part, into which the membrana tympani is inserted.

The tympanic end of the meatus slopes so that the floor is longer than the roof, and the membrana tympani which divides it from the tympanic cavity is set at an angle of about 55° with the floor, forming a correspondingly obtuse angle with the roof. It is important to remember that there is practically no osseous meatus in the infant, this being an after development.

The meatus is lined with skin which gets thinner and thinner as we proceed inwards, and in the osseous portion it is intimately connected with the periosteum. In the cartilaginous portion there are numerous soft hairs and special ceruminous glands which secrete the ear wax; while in the osseous part there are but few hairs, and the ceruminous glands are only found along the posterior and upper wall.

Middle Ear.—The *membrana tympani* divides the meatus from the tympanic cavity. It is not quite circular in form, being slightly oval, with a mean diameter of $\frac{1}{3}$ inch, resembling gold-beaters' skin both in appearance and thickness. It is inserted at an angle of 55° in the ring-like groove at the end of the meatus, as already stated, and is retracted at its centre so as to be concave; but this is not a regular cup-shaped concavity, for about midway between the retracted centre and the circumference it is slightly convex.

The membrana tympani, although so very thin, is composed of three layers, the outer one being cutaneous

(modified skin containing no hair follicles) and continuous with the skin of the meatus; the inner layer is modified mucous membrane with a single layer of tesselated epithelium. Both the cutaneous and mucous layers are well supplied with blood vessels and nerves. The middle layer or membrana propria consists of fibrous tissue. There are two layers of fibres; the outer, the fibres of which radiating from the centre to the circumference, are attached to the tip of the handle of the malleus; and the inner, which consists of circular fibres. The long handle of the malleus is thus imbedded in the membrana tympani.

At the upper part where the bony groove is deficient, this membrana propria is also wanting, and thus we have a small triangular portion of the membrane that is not so tense as the rest. This is called the membrana flaccida or Shrapnell's membrane, and in some extremely rare cases a small foramen is normally found in this position.

The tympanum.—The tympanum is an irregular bony cavity somewhat wedge-shaped in form, with its edge downwards. Its broad outer wall is partially formed by the membrana tympani. Anteriorly it is prolonged into the Eustachian tube, posteriorly it opens into the mastoid cells. The roof is formed by a more or less thin plate of bone which separates the tympanum from the cranial cavity. This is sometimes very thin, and in rare cases even wanting; hence there is considerable danger of disease extending upwards from the tympanum to the meninges.

The broad inner wall presents, just behind the opening of the Eustachian tube, a rounded projection called the promontory (with grooves on it for the tympanic plexus); posterior to and above this is the fenestra ovalis,

filled in by the foot-plate of the stapes; and below, the fenestra rotunda with its membrane stretched over it. Further back we find a small conical projection called the pyramid; this contains the stapedius muscle, the tendon of which passes through a perforation at the apex, and is inserted into the stapes. The aqueductus Fallopii, containing the portio dura, is seen as a rounded

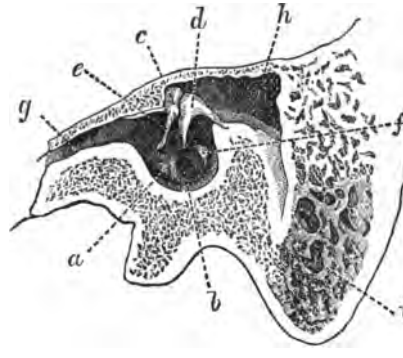

FIG. 4.—Dissection showing the tympanic cavity, the outer wall with membrana tympani having been removed. *a*. Promontory, with nerve plexus upon it; *b*. fenestra rotunda; *c*. malleus; *d*. incus; *e*. stapes; *f*. pyramid with tendon of stapedius muscle; *g*. Eustachian tube; *h*. antrum or first of the mastoid cells, large and freely communicating with the tympanic cavity, as is frequently the case; *i*. mastoid cells.

ridge projecting into the tympanic cavity at the upper and posterior part of this inner wall, and then passing downwards forms a posterior relation. Another muscle, the tensor tympani, arises in a tube above and parallel to the Eustachian tube, and makes its way along the upper surface of this wall, its tendon passing at right angles round the edge of a curled bony process —the processus cochleariformis—and is inserted into the handle of the malleus.

The ossicles in the adult are three in number; the malleus, incus and stapes.

The malleus consists of a body, neck, a long handle, (inserted between the layers of the membrana tympani) a short process, and a long slender one called the processus gracilis. The body presents a rounded head for articulation with a corresponding cavity in the adjoining bone, the incus, this articulation being a true one.

The incus, shaped like a molar tooth, consists of a body and two processes. The body, as before stated, articulates with the malleus, and the end of the longer of the two processes with the stapes. The shorter process is fastened by means of a ligament to the posterior wall of the tympanum, and partially blocks the opening into the mastoid cells.

The stapes is stirrup-shaped as its name implies. Its head articulates with the incus, and the foot plate is fixed into the fenestra ovalis by an annular ligament.

The chorda tympani nerve enters the tympanum by a small opening just behind the membrana tympani, passes across it rather above the middle (between the long handle of the malleus and the long process of the incus) and disappears by a similar opening in front of the membrana tympani.

The cavity of the tympanum contains air supplied to it by the Eustachian tube, and is lined with mucous membrane continuous with that tube. The epithelium of this mucous membrane varies considerably according to its position, from the ciliated columnar variety near the Eustachian tube to the single layer of tesselated epithelium, already described as forming the inner layer of the membrana tympani. And it is most important to bear in mind that this mucous membrane is continued over the ossicles as well as over the cavity

generally, for probably the chief cause of deafness in chronic middle ear catarrh proceeds from the thickening of the mucous membrane of the ossicles and the consequent impairment of their mobility.

Again, pathologically it is important to remember that this mucous membrane is in some parts in such intimate connection with the periosteum of the bone, that the two together form a single membrane.

Eustachian tube.—The Eustachian tube leads from the naso-pharyngeal space to the tympanum, and is nearly one inch and a half long.

The pharyngeal end, the cartilaginous portion, is composed of cartilage and fibrous tissue, and forms about two-thirds of the tube; the remaining one-third, the osseous portion, is a canal passing through the temporal bone parallel, and in close relation to the floor of the cranial cavity.

The cartilaginous portion is shaped like a flattened funnel with its large end opening into the pharynx and its small end backwards. The inner wall is formed by a plate of cartilage curled round at the top, and the outer chiefly by fibrous membrane. The bony portion forms an ordinary funnel of smaller dimensions, its large end opening into the tympanum, and its smaller one into the cartilaginous part of the tube. Thus, the narrowest point (isthmus) will be found in the osseous tube just at its junction with the cartilaginous portion, and here the opening is so small that it would scarcely admit more than a large bristle.

The Eustachian tube is lined with ciliated columnar epithelium, the cilia working so as to remove mucus from the tympanum to the pharynx.*

* In the sub-mucous tissue of the cartilaginous portion are found numerous small acinous glands. These are liable to enlargement, and thus produce obstruction to the Eustachian tube.

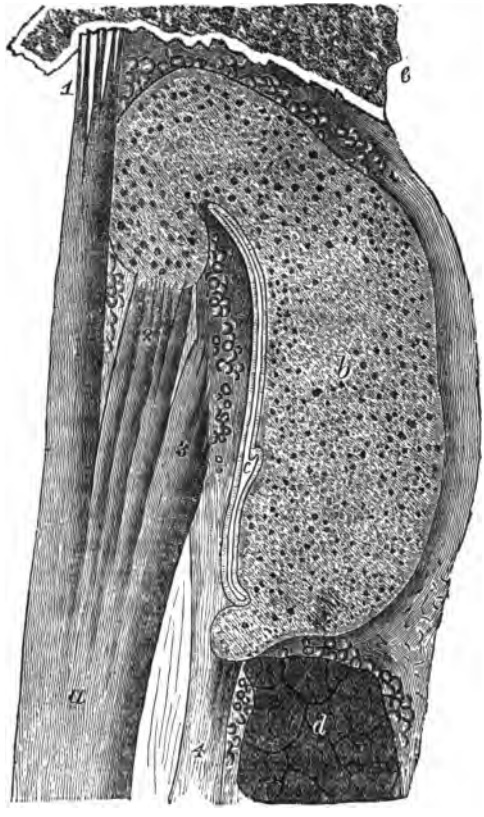

FIG. 5.—Transverse section of the cartilaginous portion of the Eustachian tube × 10 diam. Drawn from a preparation of Prof. Burckhardt-Merian.

a. Tensor palati. 1. Slip attached to the sphenoid bone. 2. Slip inserted into the curled margin of the cartilage, which acts by pulling down the curled margin, and thus opens the Eustachian tube. 3. Slip inserted into the aponeurosis attached to the membranous wall of the Eustachian tube; its action is directly to open the tube. 4. Salpingo-pharyngeal aponeurosis. *b*. Cartilage of the Eustachian tube *c*. Eustachian tube. *d*. Levator palati, seen in transverse section, on contracting it pushes the tube upwards and thus tends to open it. *e*. Sphenoid bone.

Under ordinary conditions the Eustachian tube is just patent, but not sufficiently so for the due supply of air to the tympanic cavity; but during deglutition, yawning, and certain other movements, it is opened so as to afford a free supply. This opening is effected by portions of the tensor palati and levator palati muscles which act upon the mouth of the cartilaginous tube, the chief factor being, no doubt, the slip *a*, 3, fig. 5, which is inserted into the membranous wall of the Eustachian tube.

Mastoid cells.—The mastoid process in the adult contains within its substance some irregular air-cells which vary very much in size according to the individual. These are connected with the upper and back part of the tympanic cavity. The first cell, the *antrum*, is somewhat large and almost always well developed, but the others are frequently cut off from it by bony tissue, and thus do not communicate with the tympanum, in which case they are filled with a sort of marrow.

There are no air-cells except the antrum in the infant, but they are gradually developed as the child grows.

The air-cells are lined with mucous membrane continuous with that of the tympanum, and this is intimately connected with the periosteum of the bone.

THE PERCEPTIVE APPARATUS consists of:—

1. The internal ear (containing the nerve terminations).
2. The auditory nerve.
3. The auditory nerve centre (in the brain).

The internal ear.—The internal ear is contained in the substance of the petrous bone. It consists of cavities hollowed out of this bone, called the bony labyrinth, and of a complex arrangement of membranous tubes and

sacs within it, the membranous labyrinth. The whole is filled with fluid; that which is outside the membranous labyrinth being called *epilymph*, and that within it, *endolymph*.

Externally, the bony labyrinth is in relation with the tympanic cavity, and in the macerated skull they are actually in connection by means of the fenestræ ovalis and rotunda. But in the ordinary condition direct communication is cut off by the plate of the stapes being inserted in the fenestra ovalis, and by a membrane filling in the fenestra rotunda.

Internally, the bony labyrinth is in relation to the meninges of the brain, from which it is separated by a considerable thickness of the dense petrous bone. Through this thickness passes the internal auditory meatus which contains the facial nerve (portio dura), and the auditory nerve (portio mollis), the latter being distributed to the internal ear.

The bony labyrinth consists of three parts; the *vestibule* in the centre; the *cochlea* in front; and the *semi-circular canals* behind.

The vestibule is somewhat oval in shape, its outer wall presenting the fenestra ovalis into which the plate of the stapes is fastened by means of an annular ligament. Its anterior wall has an opening into the cochlea, while on the posterior side there are five openings into the semi-circular canals.

The semi-circular canals are three in number, and each one is placed at right angles to the other. Thus, one is horizontal, another vertical, with its axis from side to side, while the third is vertical, but has its axis from back to front.

Although named semi-circular canals, they in reality describe more than a half circle, and as both ends open

into the vestibule the whole circle in each case is completed by it.

At one end of each of these canals there is an enlargement of the tube to about twice its diameter; this enlargement is called the ampulla. Each ampullated end enters the vestibule separately, as does also the other end of the external semi-circular canal; but the other ends of the superior and posterior semi-circular canals unite before entering the vestibule, and so only form one opening between them. Thus it is that there are only five openings into the vestibule instead of six.*

The membranous labyrinth of the vestibule consists of two sacs, the *utricle* and the *saccule*.

The utricle is behind and somewhat above the saccule; it is oval in shape, and into it open the three membranous canals. The utricle is adherent at one point to the saccule, and at another to the wall of the vestibule. It is composed of a fibrous membrane lined inside by epithelium, which at the point of attachment to the wall is modified for the reception of the nerves; this spot is called the macula acustica.

From the surface of the macula projects a number of stiff cilia, which are embedded in a layer of mucoid material, and in this are found the otoliths (crystals of carbonate of lime), see fig. 6.

The membranous labyrinth of the semi-circular canals has the same shape and modifications as the bony case or labyrinth to which it is attached on the outer wall of the circle. Its structure is similar to that of the utricle; and each membranous ampulla presents a crest projecting into its interior, the epithelium on which is

* The bony and membranous portions of the cochlea are so intimately connected that it will be more convenient to take their descriptions together.

modified for the reception of the nerve; this crest is named the crista acustica. Its surface is very similar to that of the macula acustica, but the cilia are longer, and the otolith mass forms a sort of cap over the crest.

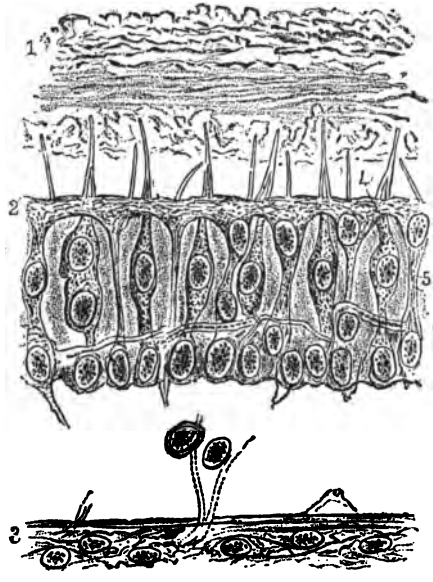

FIG. 6.—Transverse section of a portion of the macula acustica, × 750 diam, drawn from a preparation of the author's.*

1. Otolith mass into which the long cilia are projecting; the otoliths themselves. having been dissolved out. 2. Membrana reticularis limiting the nerve-epithelium and through which the cilia pass. 3. Membrana propria blended with the periostial tissue below, and accidentally detached from the nerve-epithelium. Broken nerve filaments are seen passing between. 4. A thorn-cell, or cell terminating in a thorn-shaped cilium. 5. A bristle-cell, or cell terminating in a bristle-shaped cilium.

The utricle and semi-circular canals form together the posterior labyrinth, and this is devoted to the

* The Termination of the Nerves of the Vestibule and Semi-circular Canals. *Quar. Jour. Mic. Science*, 1876.

sense of motion and equilibration. When regarded as a whole the posterior labyrinth will be seen to consist of three complete circles, the utricle uniting the ends of each semi-circular canal.

The cavity of the utricle is not directly connected with that of the saccule at their point of contact, but only indirectly united by means of a small V-shaped duct.

The saccule is spherical in shape; smaller than the utricle, but similar in structure; it also presents a similar macula acustica. A small duct, *ductus reuniens,*

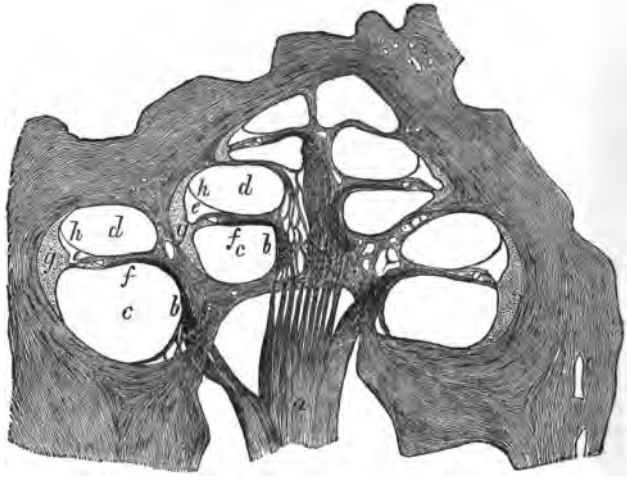

FIG. 7.—Section through the centre of the cochlea, × 8 diam., by the author. *a.* Auditory nerve. *b.* Ganglion spirale. *c.* Scala tympani. *d.* Scala vestibuli. *e.* Scala media or ductus cochleæ. *f.* Lamina spiralis. *g.* Ligamentum cochleæ. *h.* Membrane of Reissner.

leads from its lower and anterior wall to the membranous labyrinth of the cochlea. The saccule together with the far more important ductus cochleæ, to be described immediately, form the anterior membran-

ous labyrinth, which is concerned with the function of hearing.

The cochlea is shaped like the inside of a snail's shell, and consists, like it, of a spiral tube diminishing towards its apex. This tube takes two and a half turns, and is divided longitudinally into two parallel scalæ by the *lamina spiralis*, a bony plate projecting at right angles from the axis or *modiolus*. This division is completed by a membranous extension of the plate, *membranous lamina spiralis*, which is attached to the outer

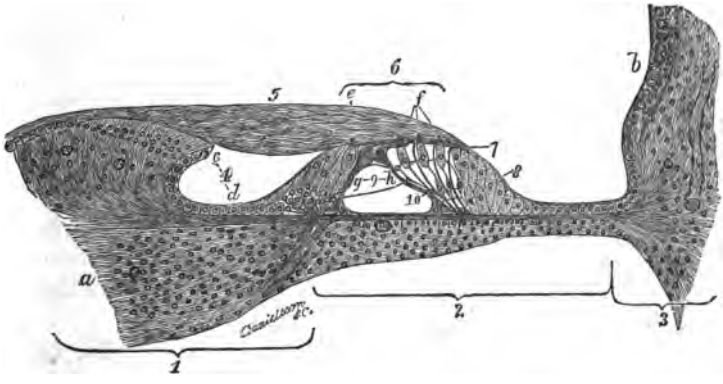

FIG. 8.—Transverse section of the lamina spiralis membranacea, × 150 diam. 1. Lamina spiralis ossea, (*a*) nerve. 2. Membrana basilaris. 3. Ligamentum cochleæ, (*b*) stria vascularis. 4. Sulcus spiralis, (*c*) upper lip, (*d*) lower lip. 5. Membrana tectoria. 6. Hair cells; (*e*) inner, (*f*) outer. 7. Membrana reticularis. 8. Supporting cells. 9. Rods of Corti; (*g*) inner, (*h*) outer. 10. Deiter's cells.

wall* of the cochlea by means of a cushion of fibrous tissue, the ligamentum cochleæ. From the upper margin of the bony lamina spiralis, not far from its outer edge, springs a very delicate membrane, *the membrane of Reissner*, which passes outwards and upwards to

* In describing the cochlea, the axis or modiolus is always considered the centre and the apex as its upper portion.

the upper part of the ligamentum cochleæ, thus cutting off a small triangular tube, the *ductus cochleæ* or *scala media.* The remaining upper portion of the tube is called the *scala vestibuli* because at its lower end it opens into the cavity of the vestibule. The lower division of the tube has been named the *scala tympani*, because it leads at its lower end to the fenestra rotunda, and is there only separated from the tympanic cavity by the membrane of the fenestra. The scalæ vestibuli and tympani unite at the apex of the cochlea.

The ductus cochleæ or scala media forms the membranous labyrinth of the cochlea. It consists of a tube, triangular in section, following the general spiral, and terminating blindly at each end; but near its lower extremity (the base of the cochlea) the ductus reuniens opens into and connects it with the saccule.

Although the tube is triangular in section throughout, its size does not remain the same; and curiously enough, instead of diminishing, its width actually increases from the base upwards, so that it follows inversely to the general diminution of the spiral.

The base of the ductus cochleæ or scala media, is formed by the membranous lamina spiralis, and a small portion of the bony lamina; its roof by the sloping membrane of Reissner, and its outer wall by the ligamentum cochleæ. It is lined with epithelium variously modified. That portion which lies on and forms part of the membranous lamina spiralis is called the organ of Corti, and receives nerve terminations. This organ of Corti consists essentially of two rows of rod-like bodies, *rods of Corti*, and of several rows of ciliated cells. The cilia are stiff, but not nearly so large as those of the vestibule; they are embedded in a mucoid layer, which, however, contains no otoliths. The nerve filaments

terminate chiefly in the ciliated cells. The rods and the cilia lengthen with the general widening of the organ of Corti from base to apex of the cochlea.

Auditory Nerve and Nerve Centre.—The auditory nerve is the portio mollis of the seventh cranial. As its name implies it is very soft and therefore much more liable to injury from pressure than its companion, the portio dura. It arises from the medulla oblongata—its deep origin being chiefly from the floor of the fourth ventricle—enters the internal auditory meatus, and then, after a very short course, is distributed to the labyrinth. There it divides into two branches; the anterior one supplies the cochlea; its fibres pass up the modiolus, then through a ganglion, *the spiral ganglion*, and terminate in the organ of Corti. The posterior branch at its origin contains a large number of ganglionic cells; it divides into five branches to be distributed to the two maculæ acusticæ, and the three cristæ acusticæ. These nerves throughout their whole course are contained within the bone until they arrive at the nerve-epithelium.

Having now briefly considered the anatomy of the auditory apparatus, it may be well to add a few words upon the rôle which the various parts play in the production of the sense of hearing.

The collecting power of the human auricle is of slight value, but still, to a certain extent, the sound-waves are directed by it into the meatus. The meatus conducts them to the tense membrana tympani, and this readily picks them up and transfers them to the chain of ossicles with which it is in intimate relationship. These mobile solid bodies, vibrating as a whole, carry on the sound waves to the fluid of the internal ear by means of the foot-plate of the stapes.

The membrana tympani and the chain of ossicles are

necessary on account of the fact that sound-waves passing from a gaseous medium (in this case, the air) into a fluid one (here represented by the epilymph) are almost entirely reflected and lost. But the tense membrana tympani is able readily to pick up the sound-waves from the gaseous medium and so transmit them to the solid ossicles, and through these they are transferred to the fluid medium without any appreciable loss.

These sound-waves will now pass through the fluid of the anterior labyrinth and affect the organ of Corti in some way not yet determined. The nerve terminations become excited, and the sensations are carried along the portio mollis to the auditory nerve centre in the brain. The actual *pitch* of the sound is probably appreciated in the cochlea; each minute division of a note affecting a corresponding portion in the spiral scale.

The saccule, which is the only part of the labyrinth found in invertebrates, very possibly can only appreciate the *intensity* of a sound.

Formerly the appreciation of the *direction* of sounds was believed to be the function of the semi-circular canals, but this is not the case; for it is easy to prove that we only learn the direction from whence a sound proceeds by comparing its intensity by the two ears. We cannot discover the position of a noise which is produced at an exactly equal distance from the two ears. Again, a person who has lost the hearing on one side is quite at a loss to know the direction whence the sound has come. This latter fact should make the surgeon always caution a patient, who has suddenly lost the hearing of one ear, to depend on his eyes and not on his remaining good ear, when crossing dangerous thoroughfares.

The function of the semi-circular canals and utricle, *the posterior labyrinth*, is now generally accepted to be that of sense of motion and consequent sense of equilibrium.

The sensation is produced in the following way. If we consider that each semi-circular canal with the utricle forms a complete circle, that at one point of this circle there is a crest covered with nerve terminations; and further, that the whole is filled with liquid, it follows that when the body is turned in the axis of this circle, the fluid tending to remain stationary, the effect of a current in the opposite direction will be the result. This current impinging on the crista acustica will excite the nerve terminations, and thus the sensation is produced.

Now the axes of the three semi-circular canals being at right angles to each other we get sensations of movement in different directions. In all probability the crista of each semi-circular canal is affected by movement of the fluid in one direction only, the corresponding canal on the other side being affected by currents in the opposite direction.

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CHAPTER II.

METHODS OF EXAMINING THE EAR—OBJECTIVE AND SUBJECTIVE.

BEFORE proceeding to the description of the various injuries and diseases to which the ear is subject, it will be convenient to devote a chapter to the methods at our disposal for examining the condition of the several parts of this organ. Although the middle and internal ears are almost entirely hidden from view, and therefore their examination is rendered very difficult, yet by making use of the subjective as well as the objective means now to be described, we are able to form a very satisfactory estimate of the condition of any part of this complicated apparatus. The objective examination of the ear resolves itself into the following:—

1. Observation, by the naked eye, of the auricle and its neighbouring parts, including the opening of the meatus.

To this may be added, observation by means of touch; *i.e.*, examination by the finger of the parts around the auricle.

2. Examination by the aid of the speculum; of the meatus, membrana tympani, and sometimes of the tympanic cavity beyond.

3. Examination of the pharynx by the naked eye, and of the naso-pharynx by means of the rhinoscope, and of the finger.

4. Examination of the Eustachian tube and tympanum by means of inflation and the diagnostic tube.

The subjective method consists of measuring the hearing power, not only of the apparatus as a whole, but also of the essential or nervous portion by itself. In other words, the hearing power of the conducting and perceptive portion together, and of the perceptive portion alone, must be carefully gauged.

1. **Inspection**, by means of the naked eye, of the parts around the auricle, I need scarcely say, is of great practical importance. Note should be taken of the state of the skin, etc., so that swelling, inflammation, boils, eczema, tumours, injuries, collapse, and malformations may not be overlooked. As, however, these points will be referred to in detail in future pages, there is no need to do more here than to remind the reader of the value of this mode of examination.

Inspection in many cases may be supplemented with advantage by palpation. Thus, hard tumours may be recognised, fluctuations felt, and the seat of tenderness discovered by the use of our fingers.

With regard to this the following general rules will be found of much practical value. Tenderness on pressure of the tragus indicates inflammation of the meatus; tenderness on deep pressure below the auricle denotes inflammation of the middle ear, (this will be readily understood when the proximity of the glenoid cavity to the tympanum is remembered). Tenderness on pressure or on percussion of the mastoid process indicates mastoid inflammation, a very serious complication, and therefore this ready means of recognising it is of great value.

2. **The speculum** is perhaps the most important auxiliary that we possess for the purposes of examination of the ear. Its *modus operandi* is exceedingly simple, its value mainly consisting in straightening the meatus so that a light can be readily thrown into it, thus enabling the surgeon to examine the parts.

There are numerous forms of specula, which may be divided into the long, short and dilating varieties.

FIG. 9.—Long Ear Speculum.

The long (fig. 9) generally consists of a long narrow funnel, oval in section so as to accommodate itself to the meatus. There are several modifications of these, and they sometimes go by the name of Wilde's, Toynbee's, or Gruber's specula. They are inserted right into the osseous meatus.

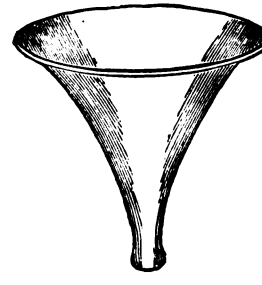

FIG. 10.—Short Ear Speculum.

Formerly this was the kind most generally used, but it has the serious disadvantage of producing much irritation and even pain during introduction, for which

reason I have always preferred one of the shorter specula; and in this opinion I believe most aural surgeons concur.

The short speculum is only introduced into the car-

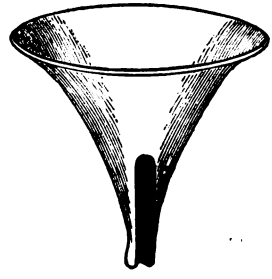

FIG. 11.—Operating Ear Speculum.

tilaginous part of the ear, but as this is the curved portion that, as a rule, is all that is necessary, and its introduction causes no pain whatever.

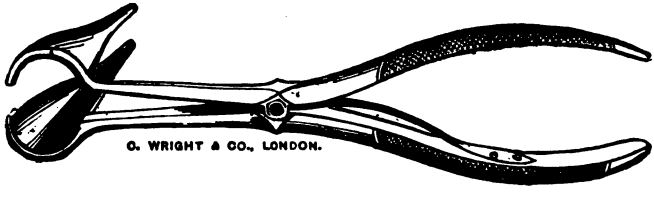

FIG. 12.—Dilating Ear Speculum.

I find it is a considerable advantage to have the speculum circular at the narrow end, instead of oval as they are sometimes made, as it allows of the instrument being turned round, which is often desirable.

The wide end is usually about ¾ inch diameter, but I like mine (fig. 10) to be about double this size, as the fingers holding it will then be more out of the way, and also the light may be thrown in at a wider angle, if

necessary. On account of the size of the meatus varying, according to whether the patient is a child or an adult, the surgeon should have a set of at least three specula, the narrow ends of which should measure from $\frac{1}{8}$ inch to $\frac{1}{7}$ inch diameter.

These specula are made of metal, vulcanite, etc., I much prefer them made of silver, very thin so that as little space as possible is lost, and I like the inner surface to be dulled.

When operating with such an instrument as a pair of orceps I use a speculum (see fig. 11) from the narrow end of which a portion has been removed so as to allow of the instrument being opened.

The dilating speculum (fig. 12) consists of two blades like other bi-valve specula. These are introduced when closed, and then dilated either by means of a

FIG. 13.—Siegle's Pneumatic Speculum.

screw or a handle. This kind is occasionally useful when the meatus is much flattened or collapsed.

Siegle's pneumatic speculum (fig. 13) is an ingenious modification of the speculum devised for the purpose of examining the mobility of the membrana tympani. It consists of an ordinary short speculum with its narrow

end covered with India rubber to make it fit the meatus more accurately. A piece of glass fits closely and obliquely across the wide end, and below this is a small opening at the side from which proceeds a piece of India rubber tubing terminating in a ball or in a mouth-piece.

The speculum must be firmly fixed in the ear so as to prevent any entrance or exit of air. The membrane is then inspected, and at the same time the atmospheric pressure upon the meatus is alternately increased and diminished by pressing and relaxing the India rubber ball; or, when there is a mouth-piece instead of a ball, the surgeon produces rarefaction or condensation by means of his own mouth. The effect of this alternation is to move the membrane inwards and outwards if the normal mobility exists. By this method the surgeon can tell if the membrane is free or whether it is fixed by adhesions.

Mode of illumination.—1. By *direct daylight.*—The speculum having been introduced into the meatus, the head of the patient is placed so that the light from a window falls straight into the ear. This is frequently all that is necessary, but it has the great disadvantage of requiring the head of the patient to be adapted to the light, and thus the least deviation on his part stops the examination.

2. By *reflected daylight.*—A mirror, either held in the hand, or still better, fixed on the forehead in a manner similar to that employed for the laryngoscope, is used to throw the light—best taken from a northern aspect—into the ear.

This is one of the best modes of illumination, because the light may thus be easily adapted to the patient's ear; any slight movement on his part being readily followed up by that of the surgeon. Moreover, with

Brunton's auriscope.—This very ingenious apparatus combines the speculum with the illuminating instrument (see fig. 16). It consists of a tube which fits on

FIG. 16.—Brunton's auriscope.

to the enlarged end of the speculum, and to the other end a single lens is adapted. At about the middle of this tube a slanting mirror with a hole in the centre is adjusted, and the light brought to this by means of a funnel inserted at right angles into the tube. The light thus thrown on to the mirror is reflected by it straight into the meatus and so illuminates it; and the observer, looking down the tube through the eyepiece and through the centre of the mirror is thus able to see the illuminated parts.

This auriscope is used by some aural surgeons in preference to all other methods.

Introduction of the speculum.—This may, at first sight, appear to be too simple an affair to require direction, but it does need some little practice before it can be properly introduced so as to enable the surgeon to obtain a good view.

The speculum, warmed by friction, being held between the first finger and thumb of the left hand, the auricle should be laid hold of between the other fingers of the same hand and drawn upwards and outwards with a slight twist so as to straighten the meatus; the speculum can then be readily inserted. When the meatus is much collapsed, both hands should be used.

Care must be taken that the long axis of the speculum is adapted to that of the meatus, otherwise it may point to some portion of its walls instead of to the membrana tympani, and so occasion an erroneous diagnosis. For instance, should there chance to be a somewhat thick layer of cerumen on the floor of the meatus and the speculum be directed on to this, it will appear as though the meatus was completely filled by a plug of wax.

Appearance of the normal meatus and membrana tympani.—It will be convenient here to make a few remarks upon what is seen in a normal ear by the help of the speculum.

As the speculum is being introduced into the cartilaginous portion of the meatus, a number of extremely fine hairs will be noticed; these sometimes are very abundant, and may then obscure the view until the speculum has passed them. Besides these, a thin layer of cerumen will be noted, and this, usually thicker at the floor, may sometimes enter the speculum and so obstruct the view.

When the speculum (short) is fully introduced only the osseous meatus and the membrana tympani can be

seen. The osseous meatus presents a smooth pale pink appearance.

The membrana tympani (see frontispiece) which forms the background of our view, is tense, smooth and of a pearly semi-transparency like a stretched piece of gold-beater's skin. The centre is more retracted than the rest and from this centre, *the umbo*, passing upwards and slightly forwards, is seen the handle of the malleus between the layers of the membrane. This terminates near the upper margin in a slightly pointed prominence, *the short process* of the malleus, and from this point indistinct folds or bands pass forwards and backwards; between these bands, just above the malleus, may be seen the membrana flaccida. But the whole of this upper portion of the membrane is ill-defined, and its junction with the meatus itself indiscernable on account of the obtuse angle at which they meet.

When the membrane is unduly retracted (in cases of Eustachian obstruction) the short process of the malleus and the upper portion of the handle become very prominent, as also do the folds already described, thus forming an anterior and a posterior pocket in which may be lodged débris of all kinds. At the upper part of the posterior pocket the long process of the incus may sometimes be seen through the membrane.

A triangular spot of light will be seen passing from the umbo, or retracted centre, forwards and downwards to the margin of the membrane, the apex of the triangle being towards the umbo and the base towards the circumference; the brightest portion is midway between these. This triangular spot is due to the reflection of the light used in examining the meatus and it therefore becomes altered in appearance when the membrane is displaced. Thus, if the membrane is a little too con-

cave, the spot ceases before it reaches the circumference; and when the concavity is still greater it appears merely as a rounded bright spot close to the umbo, or it may be entirely lost.

To the surgeon these different appearances of the bright spot are very useful indications in forming a diagnosis.

The anterior and lower margin of the membrane is frequently out of sight on account of the curvature of the meatus, the amount of which varies in different individuals.

When the membrane is partially lost by disease the inner wall of the tympanum comes into view. This will be found lined with a pink mucous membrane. The promontory is the portion most frequently seen, but in some rare cases, where nearly the whole of the membrane and the two first ossicles have been lost, an almost complete view of this inner wall may be obtained.

3. **Examination of the pharynx** by the naked eye, and of the naso-pharynx by means of the rhinoscope and the finger.

In all cases of ear disease it is absolutely necessary to examine the pharynx because a very large majority depend, either directly or indirectly, on some affection of the pharynx. This is examined in the ordinary way, using a spatula to hold down the tongue, and a good light directed into the throat; at the same time the patient should be requested to say 'Ah' so as to raise the soft palate. The surgeon should especially look out for the following:—catarrh of the mucous membrane with or without thickening; granulations; adenoid growths; enlarged tonsils.

It is sometimes advisable to examine the naso-pharynx by means of posterior rhinoscopy, but as a rule this is unnecessary. It is, however, always important to note

whether the air passes freely through the nasal passages; and occasionally anterior rhinoscopy is of service when obstruction or disease of these passages exists.

When the presence of adenoid growths is suspected in the naso-pharynx, it should be examined by means of the finger passed up and behind the soft palate; thus they may be readily detected.*

4. **Examination of the Eustachian tube and tympanum** by means of inflation and the diagnostic tube.

It is almost invariably necessary to examine the Eustachian tube so as to ascertain whether it is obstructed. This is done by means of the diagnostic tube combined with one of the following modes of inflation; Valsalva's method, Politzer's method, or the catheter.

The diagnostic tube consists of a piece of India-rubber tubing, two to three feet long, with or without ivory ends. One end is inserted into the patient's meatus and the other into that of the surgeon; thus the surgeon is able to hear the various sounds produced in the Eustachian tube and tympanum during inflation.

In the normal ear when the tympanum is inflated a dull click is heard, if a perforation exists a whistling is distinctly audible; while the presence of fluid is indicated by moist sounds.

Some authorities lay great stress on the diagnostic character of the various sounds that may thus be heard; however, it requires a practised ear rightly to appreciate the value of any but the three just mentioned.

Methods of inflation.—In the normal state we find that the Eustachian tube is constantly being opened, either by the act of swallowing or by some other move-

* For further information the reader is referred to Cresswell Baber's *Guide to the Examination of the Nose.*

ment of the pharynx. It is by this means that the air in the tympanum is renewed, causing the pressure on each side of the membrana tympani to become equalised.

Valsalva's method of inflating the tympanum is merely a forcible imitation of the above natural method. It is performed by holding the nose, closing the mouth, blowing out the cheeks and at the same time attempting to swallow. The swallowing opens the Eustachian tube and the air is then forced through the tube into the tympanum and can be felt distending the membrane. It rarely needs more than a little practice to succeed if the Eustachian tubes are not much obstructed. Sometimes when the patient is unable to do this, the desired result may be brought about by letting go of the nostril at the moment of swallowing. This little modification was pointed out a few years ago by my colleague, Dr. Matheson.

Politzer's method.—This bag (fig. 17) is perhaps the most valuable instrument that we aural surgeons possess. It was devised by Prof. Politzer of Vienna, and consists of an ordinary India-rubber bag (six to eight oz. contents) to which is adapted a nozzle to be introduced into the nostril, so that a forcible injection of air may be introduced into the naso-pharynx through the nose at the moment of deglutition; thus enabling us to overcome a much greater obstruction in the tube than could be done by Valsalva's method. The handiest way of using Politzer's bag is as follows. The patient should be given a sip of water to hold in the mouth which must be firmly closed, with the head thrown a little backward. The surgeon then introduces the nozzle of the bag into one nostril, holding the nose so as to close the rest of it completely, and the patient now being told to swallow the water, the bag must be squeezed forcibly as soon as

the larynx is seen to move. Instead of swallowing water the patient may say the word 'hick' (aspirating the *h* well) the surgeon inflating at the same moment. Or again during crying inflation may be readily performed. Lastly, with young children no swallowing is necessary.

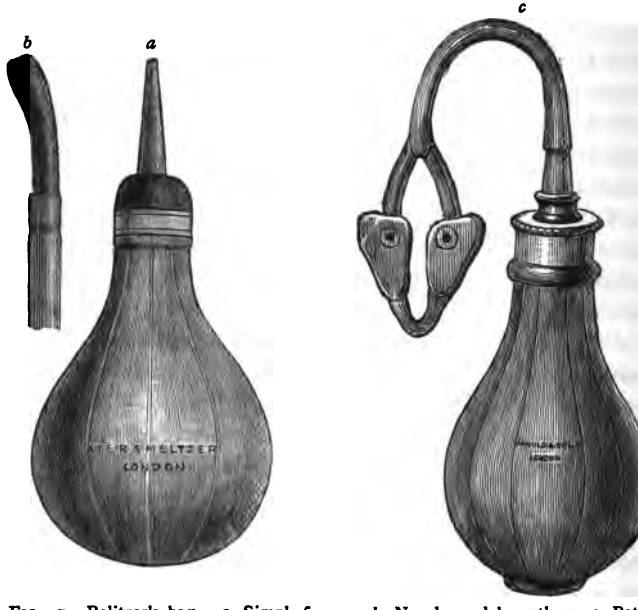

FIG. 17.—Politzer's bag. *a*. Simple form. *b*. Nozzle used by author. *c*. Peter Allen's form.

Numerous modifications of this bag have been made. Sometimes a valve is adapted to the bottom or to the neck of the bag so as to allow of the entrance of air otherwise than through the nozzle. For ordinary purposes, however, I do not like this, for not only are the valves very liable to get out of order, but the complexity

of the apparatus militates against its use; while some manufacturers make matters worse by placing the valve in the tube leading to the nozzle in such a way as to interfere with the direct exit of air, thereby greatly diminishing the force of the inflation.

The late Peter Allen devised a double nozzle with cushions to press against the nostrils. This form is sometimes of service (fig. 17, *c*). Again, some aural surgeons prefer merely a short wooden nozzle connected with the bag (fig. 17, *a*), this has the advantage of obtaining the fullest possible force. Others like a long narrow india-rubber tube between the bag and the nozzle, which is handy for use, but much force is lost.

I prefer an eight ounce India-rubber bag fitted with a piece of stout rubber tubing two inches long of large calibre, mounted with a wooden nozzle which is oval in section and slightly bent (see fig. 17, *b*). These nozzles are easily adapted to the nostril, and the tubing is neither small enough nor long enough to interfere with the force of the bag.*

Another modification of this method, which is very useful sometimes with nervous children, consists of a tube similar to the diagnostic tube. One end is introduced into the patient's nostril while the surgeon puts the other into his mouth and blows forcibly through it, thus inflating the tympanic cavities.

The Eustachian catheter.—Before the introduction of Politzer's bag the surgeon generally relied on this instrument for inflating the tympanum; and even now, the catheter combined with Politzer's bag is a very favourite and useful method of inflation.

The catheter consists of a silver, vulcanite, or gum

* These are manufactured by Messrs. Mayer and Meltzer, and by Messrs. Hawksley and Co.

elastic tube about six inches long, curved at one end (see fig. 18). This is introduced along the inferior meatus of the nose and so through into the Eustachian tube; the surgeon then inflates the tympanum either by

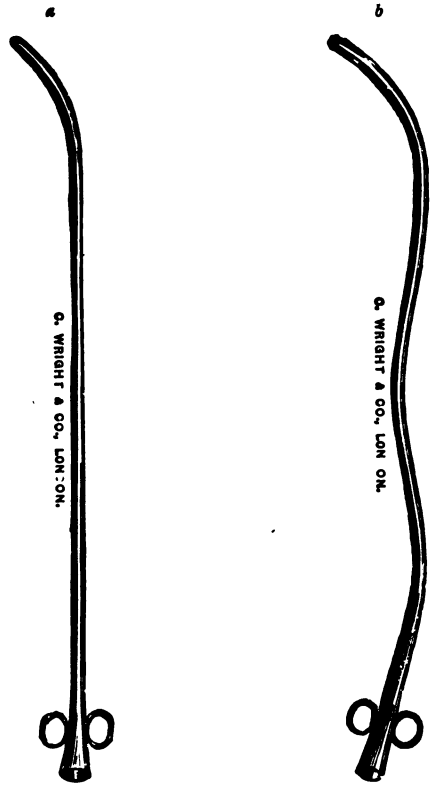

FIG. 18.—Eustachian catheter. *a*. Simple form. *b*. Double curve form

his own mouth or by a Politzer's bag adapted to the catheter.

Mode of introduction.—The introduction of the Eusta-

chian catheter requires a certain amount of knack, and even in practised hands it is in some cases impossible to use it satisfactorily on account of irregularities in the nasal passages. The following is perhaps the best mode of procedure.

The curved end is introduced into one nostril, keeping the beak close along the angle formed by the septum and the floor. By this means the surgeon will avoid getting into the middle meatus and so finding himself in a difficulty further on.

When the catheter has passed the posterior nares it will soon encounter the back of the pharynx; this will be easily recognised by its tension, for it has been very aptly described as feeling like the out-stretched palm of the hand. The catheter should then be withdrawn about half an inch, and the point turned almost directly outwards, after which, on the catheter being again slightly pushed in, the point will enter the Eustachian tube. That it has so entered may be ascertained first, by noticing that the point is apparently grasped so as to give a slight resistance to withdrawal, and second, by the result of inflation. On inflation by the mouth, if the catheter is in the Eustachian tube, a distinct and peculiar vibration is felt by the surgeon even though the Eustachian tube is too much blocked to be opened. And if it is open the air may be heard entering by means of the diagnostic tube.

Now this little operation is always disagreeable to the patient and sometimes even very painful. Therefore it should be performed lightly and dexterously, and without the least forcing. At the same time it is well, if possible, to pass the catheter rapidly through the nasal meatus as it will then produce less irritation; but should the point meet with any obstruction the catheter must be carefully humoured so as to pass on one side of it.

Frequently the nostril on one side is so much encroached upon by the septum that there is not room for the entrance of the catheter. In such cases the instrument should be introduced through the other nostril which will generally be found correspondingly large. For this purpose it is well to use a catheter with a sharper curve and then it is quite as easy to introduce it into the Eustachian tube as if it were passed through the corresponding nostril.

The use of the catheter has been very much superseded by the introduction of Politzer's bag, but when it is necessary to direct much force into the tube or to introduce fluids, etc., into the tympanum then it is desirable to make use of it. Again, where one Eustachian tube is unobstructed and the hearing good on that side, while the other one is blocked, the catheter should be used lest the healthy tympanum be over-inflated. This over inflation may frequently be obviated by causing the patient to press the tragus firmly into the meatus on the normal side so as to back up the membrane with a resisting column of air, still, it must be remembered that this does not take the pressure from the fenestræ.

Dangers of emphysema by catheterisation.—There is a rare form of accident that sometimes occurs through the use of the catheter. If its point should wound the mucous membrane so as to get beneath the surface, inflation will produce emphysema of the sub-mucous tissue of the whole pharynx and adjacent parts. Probably, however, this very rarely occurs except when the point has passed through an ulcer; and although it occasions excessive discomfort no really serious result from the accident has been recorded.

To avoid the risk of this the point of the catheter should be well rounded and quite smooth.

I may here mention that there is one other method of inflation and that is the force pump. The air is highly compressed in a metal chamber and then allowed to escape suddenly by means of a tube and catheter into the Eustachian tube, thus obtaining the effect of Politzer's bag only much more forcibly. This requires to be used with the utmost caution; and although it may in certain cases be applied with advantage, there is some risk in doing so. The late Dr. Turnbull had two cases of sudden death after its use; and, curiously enough, the post-mortems did not show evidence of the real cause of death.

Subjective Method of Examination.

We have now to consider the methods of measuring the hearing power.

1. As a whole, that is to say, of the conducting and perceptive portion together. 2. Of the perceptive portion alone.

1. **The hearing power as a whole.** In speaking of this we must take into consideration first the pitch and next the intensity of the sound.

Pitch.—The human ear is able to appreciate sounds produced by vibrations ranging from 15 to 40,960 per second.* The limits, however, vary in different individuals. In disease, also, this limit is very often affected. Generally it is the low pitch sounds, those produced by the fewer number of vibrations, that are most easily lost. For instance, a patient who can hear distinctly a conversation within five or six feet may be unable to hear thunder. Occasionally the reverse is met with,

* Preyer, Jena, 1876, quoted by Burnett, p. 200.

where the higher notes or those of some other parts of the scale are readily lost.

As a rule when the patient fails to hear the higher notes the internal ear is affected, and when he loses the lower sounds the external or middle ear is at fault. Thus it is, as pointed out by Roosa,* that in internal ear deafness, the voice (vibrations of speech vary from 16 to 4,324 per second according to Wolf) is heard more distinctly than the higher note of the watch tick; and in some cases of middle ear deafness the reverse is very marked. Again in many cases of conduction (middle or external ear) deafness, the patient will hear notes of Galton's whistle higher than those heard by an average normal ear.† More rarely it happens that the pitch of the sound is altered, that is to say, the sound seems, to the affected ear, to be either sharper or flatter than it actually is. As this peculiarity usually affects one ear only, we shall find, if the alteration of the pitch is sufficiently great, that the patient will hear a single sound as a double one because of its being differently perceived by the two ears.

To ascertain which ear is at fault we must make use of the tuning fork. If this is sounded and brought first near one ear and then near the other, the patient each time imitating the note, the surgeon will be able to recognise the normal ear by the fact that the note sounded on that side corresponds correctly with that of the tuning fork.

This is a very rare symptom occurring generally in middle ear catarrh; and is probably due to altered tension of the labyrinthine fluids produced by pressure of the stapes; this altered tension causes the sound to

* International Otol. Congress, Bale, 1884.

† Burckhardt, International Otol. Congress, 1884, Bale.

affect the lamina spiralis higher up or lower down the spiral than it should, and in consequence the sensation is carried by a different nerve-filament to the brain.*

This condition is very annoying to the patient if he is a musician, but fortunately it readily yields to the ordinary treatment of simple middle ear catarrh.

We pass on now to the measurement of the *intensity* or loudness of the sound.

The hearing power, *i.e.*, the power of hearing sounds of a medium pitch, may be measured in normal ears and in a very large proportion of defective ones, either by means of a watch, the Acoumeter, or by the Sonometer.

A description of Politzer's Acoumeter will be found in his work on *Diseases of the Ear*, page 164. It consists of a steal cylinder carefully tuned, and a percussion hammer; the whole so arranged as to produce a sound of constant intensity and pitch.

The Sonometer is a complicated arrangement of microphone, telephone, two coils and battery, and a graduated scale to indicate the hearing power.

Undoubtedly these two form very accurate means of measurement, but for practical purposes the watch is more convenient.

Two watches should be kept for use; one with a hearing distance of from fifty to seventy inches, and another of from twenty to thirty feet, the latter for very deaf cases. The average normal hearing distance of each watch is obtained by carefully measuring several normal ears; then by means of these watches and an ordinary tape measure the surgeon can readily ascertain the amount of hearing distance possessed by the patient.

* I am aware that this explanation of mine is not received by all, but it appears to me to be the simplest and most probable one.

In applying this test, however, some little care must be taken lest the patient should fancy that he hears the tick further off than he really does. The best plan is first to let the patient hear the watch close to his ear for a moment, and then taking it quite far off, gradually bring it nearer again until it just reaches the point where the ticking is unmistakably heard.

This distance being noted and compared with the normal hearing distance of the watch, we describe the hearing distance of the patient either in the form of a fraction or percentage; thus, if the patient hears a fifty inch watch five inches off his hearing distance would be represented by $\frac{5}{50}$ or ten per cent. By keeping a record of the hearing distance in fraction or percentage the surgeon is able to refer back at any future time for the purposes of comparison. It must be remembered, however, that, as sounds decrease in intensity according to the square of the distance and not in a direct ratio, this hearing *distance* does not truly represent the hearing *power;* for instance, half the hearing power with a forty-nine inch watch, is not twenty-four and a half inches, but seven inches. Thus it will be seen, a very slight loss of hearing power will reduce the hearing distance to two-thirds or one half.

As already stated, the watch tick is not heard so well as the voice in cases of internal ear deafness; this must be taken into account when estimating the hearing power in such cases by means of the watch. Again the surgeon must be on his guard for those occasional instances of middle ear affection where the reverse holds good, or he may be very much misled. One of my patients afforded an admirable illustration of an extreme case of this kind. The watch hearing distance being sixty per cent. it would seem as though his

deafness would be scarcely apparent, and yet he was unable to hear anything but very loud conversation with that ear.

The hearing power can also be guaged to a certain extent, though of course, not with great exactitude, by means of conversation. But although this is a valuable help to an experienced observer it is only after much constant practice that the surgeon can rely upon it as a trustworthy guide.

2. **Measurement of the perceptive portion,** or internal ear, alone.

If a sound is produced by the vibration of any solid body, and that body is placed in contact with the head, the sound waves will be carried chiefly by means of the skull bones direct to the internal ear.

For example, the tick of the watch held in the teeth may be distinctly heard through the bones of the skull. Or a tuning fork sounded and brought in contact with any part of the head is similarly heard.

Now it is a curious fact, the reason for which is not yet fully understood, that whenever the conductors (the external or middle ears) are at fault the skull sounds are heard more loudly. Thus, if a tuning fork is brought in contact with the bridge of the nose, and one ear deafened by closing it with the finger;* the tuning fork will be heard distinctly in the deafened ear and probably not at all on the other side. By this means we are generally able to ascertain, in a case of deafness, whether the fault lies with the conductors or with the perceptive portion of the organ.

But we can go further, and, with a fair amount of

* The finger must not be pressed too firmly into the meatus, or else, as pointed out by Mr. Cresswell Baber of Brighton, this phenomenon does not occur.

precision, measure the hearing power of the internal ear by the following method, for which we are indebted to the ingenuity of the late Mr. Gardiner Brown.

He found that by taking a tuning fork of medium pitch and applying it, when sounded, to the bridge of the nose of a person with normal hearing, he could feel the vibrations of the fork with his fingers for exactly the same length of time as the other could hear the sound of it. The tuning fork, he found, could also be applied in a similar manner to the mastoid processes.

FIG. 19. Gardiner Brown's tuning fork.

Mr. Gardiner Brown therefore proposed to measure the amount of skull hearing in patients, by counting in seconds—plus or minus—the lapse of time between the surgeon ceasing to feel the vibrations and the patient ceasing to hear them.

This method is sufficiently accurate to form a very valuable help in diagnosis, although it cannot always be regarded as an infallible guide.*

My plan of making use of it, is generally as follows:—

The tuning fork being sounded and the stem held midway between the finger and thumb, its end is firmly applied to the part to be tested (bridge of nose or mastoid process).

I hold my watch in the palm of the left hand and request the patient to put his finger on that hand, and to lift

* When, at the International Medical Congress of 1881, Mr. Gardiner Brown described these observations, he met with much adverse criticism, but this was chiefly because his critics were not sufficiently careful in their method of testing, and therefore failed to obtain successful results.

it immediately he ceases to hear the sound. Keeping my eye on the second hand of my watch I can note exactly the time between his ceasing to hear the sound, and my ceasing to feel the vibration. This is marked plus or minus according as the patient hears it for a longer or a shorter time—than I feel it.

The tuning fork used should be of medium pitch, and it should also be one that vibrates well. I find that as a rule the sound is heard from a half to one second longer on the mastoid than on the bridge of the nose.

The following examples will illustrate the value of this test combined with that of the watch.

A. B. complained of marked deafness on the right side. Was found by the watch to have normal hearing distance on left side, whereas on the right the watch could not be heard at all.

A tuning fork applied to the bridge of the nose was heard the normal length of time, *i.e.*, 0″; applied to the right mastoid it was 3″—; and to the left mastoid ½″+.

Such indications point conclusively to a serious affection of the perceptive portion of the right ear.

C. D., another case of marked deafness of right ear only.

Watch hearing distance { Right side, only on contact; Left, normal.

Tuning fork { On nose, 6″+, but sound all referred to right ear.

On mastoid { Right, 6½″+ Left, 4″+, but all sounds referred to right ear.

The surgeon will readily diagnose this case as one where the conducting apparatus on the right side was alone at fault.

E. F. complained of considerable deafness of both ears.

Watch distance { Right, 1 per cent.
Left, 1 per cent.

Tuning fork { Nose, 3″—
Each mastoid, 2½″—.

Such indications point to affection of the perceptive portion on each side.

Again we may have both the conductors and the perceptive organs affected, as in the following case:—

G. H., complained of considerable deafness.

Watch hearing distance { Right, 2 per cent.
Left, 2 per cent.

Tuning fork { Nose, 0″
On each Mastoid, ½″+.

Here the fault in the conductors (which would lengthen the time of the tuning fork hearing) is neutralised by the affection of the internal ear (which would diminish it).

To make proper use of this method the surgeon's fingers require a little education, so as to perceive the exact moment that the vibrations cease; further, he should never rely on a single experiment but try it two or three times before he is satisfied with the accuracy of his patient; and lastly, he must make sure the patient *hears*, and not merely *feels* the vibrations of the tuning fork; this mistake is apt to be made if the patient is suffering from internal ear deafness.

Although, as we have just seen, the tuning fork test is most valuable, yet it must not be regarded as absolutely infallible. For we do occasionally meet with cases where the tuning fork indicates a *minus* quantity without the perceptive apparatus being defective.

CHAPTER III.

MALFORMATIONS, INJURIES AND DISEASES OF THE AURICLE.

MALFORMATIONS of the auricle are usually due to the non-development of some part of the skeleton of elastic cartilage, the result of intra-uterine inflammation, adhesion, etc. It is frequently associated with imperforate, or imperfect meatus, and it is only in such cases that there is any appreciable loss of hearing.

These cases rarely call for any interference on the part of the surgeon, although their unsightly appearance frequently causes them to be brought under his notice by the anxious parent.

Occasionally we meet with undue prominence of the auricle, but this condition also is of no real importance unless the prominence is due to disease of the mastoid process, a disease which will be described later on.

The reverse of this, namely, a flattening of the auricle to the side of the head, is of more frequent occurrence, especially among women; and is induced by the habit, when long persisted in, of wearing the bonnet or cap tied tightly over the ears. As this is no longer a prevalent fashion, this malformation of the auricle does not occur so often as it formerly did. In itself it is of no importance unless it is associated with collapse of the meatus.

INJURIES.—In spite of the exposed position of the auricle, injuries to it are comparatively rare, this immunity being largely due to the elasticity of its framework.

Amputation of the entire auricle is a form of mutila-

tion sometimes practised by barbarous people on their captives; but when once the wound has healed, there is no call for surgical interference, and it is stated that there is no appreciable loss of hearing power.

Heavy ear-rings not only drag down the lobe but will sometimes cut right through it. This may cause inflammation requiring treatment according to ordinary rules; otherwise, beyond its ugliness, it is of little import and needs no special treatment.

Or the cartilage may be accidentally divided by some instrument or sharp substance—such as broken glass, etc. In this case, the hæmorrhage may be very smart on account of the blood-vessels not being able to retract readily. Tortion of the vessels and pressure are usually sufficient to stop the bleeding, but the pressure must not be too great, or necrosis of a portion of the cartilage may result. If stitches are necessary to bring the parts together, they should not be carried through the cartilage, but only through the cutis; wire sutures are to be preferred as ulceration or necrosis of the cartilage is readily set up.

Diseases of the Auricle.—Simple inflammation rarely affects the auricle alone, therefore there is no occasion to note that form of disease here.

Nor is it necessary in a work like the present to enter into the subject of erysipelas, for although cases of facial erysipelas often commence by affecting the auricle, spreading from thence over the face, still implication of this part does not necessitate any modification in the treatment of such cases. It is, however, very important that the surgeon should bear this in mind, lest he mistake an early case of erysipelas of the face for simple local inflammation of the auricle.

Eczema very commonly affects this part, but will be considered together with eczema of the meatus.

TUMOURS OF THE AURICLE:—

Fibrous
Fibro-cartilaginous
Cysts { Sebaceous
Serous and Sanguineous }
Carcinomatous.

Fibrous.—Occasionally the auricle is the seat of fibrous tumours. These appear as rounded masses, usually on the anterior surface of the auricle, and may be easily mistaken for cysts. The treatment consists in removal by enucleation in the usual way; they rarely give any further trouble, except those resulting from ear piercings which are apt to recur.

Fibro-cartilaginous tumours are also met with, growing from the cartilaginous skeleton. These do not differ from similar tumours in other parts of the body, and should be removed in the ordinary way.

Sebaceous cysts are very common in the lobe and in the anterior surface of the concha. They result from the closure of a sebaceous gland and the inordinate increase of its contents, and are very liable to inflammation and suppuration.

Treatment.—In some cases the simple evacuation of the contents is sufficient to destroy the cyst, but more frequently it is necessary to dissect out the cyst-wall. When from former inflammation the cyst-wall is too adherent to be dissected out, its secreting surface should be destroyed by the application of some re-agent, such as tincture of iodine.

Serous and sanguineous cysts, hæmatoma auris.—The upper part of the anterior surface of the auricle is sometimes subject to a peculiar form of cyst which has been called hæmatoma auris or othæmatoma. This occurs more frequently, though not exclusively, in lunatics; it

may be caused by a blow, intense cold, or by some interference with the trophic innervation of this part. It appears as a swelling filling up the concavity of the auricle and frequently bulging outwards, and results from a separation of the closely adherent skin from the cartilage, and to the extravasation of serum or blood between these two. Many authors describe the extravasation as usually consisting of blood, but according to my experience it is far more frequently serous. Again, some of the older authorities considered this disease as a sign of insanity, but this is now generally admitted to be by no means the case.

Course and Treatment.—If allowed to remain unmolested the contents gradually become absorbed, leaving a considerable amount of thickening behind, which always makes the auricle very unsightly. In considering the treatment care must be taken to prevent suppuration. I have obtained the best results by exhausting the cyst by means of a subcutaneous syringe, and then injecting a dilute solution of iodine (tinc. iodine 1 part, water 2 parts). This solution should be removed by the syringe after it has remained in the cyst a few minutes.

Carcinoma.—The auricle is very rarely the seat of carcinoma, but when it does occur it is in the form of epithelioma, and differs in no way from epithelioma in other parts of the body.

Treatment.—Complete and free removal should be promptly adopted unless it has so far advanced that it has involved the neighbouring tissues and glands. In such cases the treatment can only be palliative.

CHAPTER IV.

EXTERNAL AUDITORY MEATUS—MALFORMATIONS, INJURIES, OBSTRUCTIONS AND DISEASES.

CONGENITAL MALFORMATIONS are due either to abnormal development or to adhesions following intra-uterine inflammation.

Imperforate meatus.—The meatus may be partially or completely obliterated; this condition is usually associated with some malformation of the auricle. Sometimes there is a difficulty in finding the meatus, but even in the worst cases some kind of *cul de sac* will generally be found. The occlusion is sometimes osseous as well as fleshy. The amount of hearing in these cases differs considerably, but in all there must be a certain deficiency; now and again we meet with patients who can hear moderately loud conversation, but frequently the ear so affected is quite useless.

Treatment.—If the condition is only found on one side no interference is advisable, but should both ears be affected it may then become a case for operation. Even here, however, this should only be done if there is already a considerable amount of hearing power, for if there is an occlusion of the bone as well as of the soft parts no operation can possibly be of use.

Method of Operating.—The patient having been placed under the influence of anæsthetics, the surgeon should make a crucial incision through the soft tissues obstructing the meatus. Then a small ivory or silver meatus

tube with the usual shield (see fig. 20) must be inserted to prevent the surfaces from uniting again.

Although this operation may appear at first sight to be a very simple one, I should never recommend its being performed except in the most favourable cases, because there is always a great tendency to granulate up and heal across, and thus cause a return to the former condition.

Collapse of the meatus.—This condition, partial or complete, used to be very commonly met with in elderly women who had been in the habit of wearing their bonnet and cap tightly drawn over their ears. Partial collapse of the meatus favours the accumulation of cerumen, and this assists in producing deafness. Complete collapse is in itself a cause of deafness.

I have also met with another cause of collapse; namely, strumous hypertrophy of the connective tissue about the auricle, the same cause as that which produces strumous thickening of the lips.

FIG. 20.—Meatus tube.

The treatment consists in making the patient wear a meatus tube (see fig. 20) so as to open up the canal. This is a tube made of silver, vulcanite, or other material about $\frac{5}{8}$ inch long with a shell-shaped shield at one end to prevent its slipping in too far. As a rule this tube should not be worn more than two or three hours a day at first lest it set up inflammation, but as soon as the ear is able to tolerate it the tube should be left in the whole day, but removed at night. By the use of this tube in complete collapse the patient may regain

perfect hearing power, and after it has been worn some time the meatus will generally have become so patent that its further use may be dispensed with.

The report of such successful results, combined with the small size of the tube, makes a large number of deaf patients anxious to try it, although they themselves may not have the meatus at all collapsed. Many unscrupulous vendors encourage them in this desire, and in fact, I believe more of these tubes are sold to people to whom they can be of no service whatever, than to those who really need their aid.

INJURIES.—Occasionally the meatus is injured by the introduction of sharp pointed instruments, such as hairpins, &c., either by the patient himself or by some officious friend, for the purpose of removing wax or other supposed obstruction. Again, injuries are at times produced by surgeons while attempting to remove foreign bodies by means of instruments such as forceps, probes, etc. Very occasionally bullet wounds are met with in this region, but then the injury to the meatus ceases to be the source of anxiety to the surgeon on account of the far more serious mischief to the cranium.

Treatment.—As a rule it is only necessary in ordinary cases to allay the inflammation and so allow the wounded surfaces to heal.

OBSTRUCTIONS.—By accumulations, by foreign bodies. (The obstruction which results from inflammation, etc., will be treated later on).

Accumulations.—These occur very commonly, and consist either of cerumen, epidermis, hairs; of inspissated pus; or of two or more of these mixed together.

Accumulations are perhaps most frequently composed of cerumen and epidermis, together forming a more or less compact plug. Sometimes there is only a small

proportion of epidermis, while at others the plug is mainly composed of layers upon layers of it, the laminated mass having a pearly white appearance.

Occasionally the small hairs from the tragus form a considerable part of the accumulation. Again, at times it occurs towards the termination of a case of chronic otorrhœa, then it consists partially of old inspissated and dried pus; in many of these cases the formation of the plug actually assists in curing the otorrhœa.

The causes of these accumulations, except in the last mentioned, are not fully understood. Exposure to cold or any of the diseases which produce desquamation, may be the cause, but in by far the larger number of instances it would appear to be due to a bad habit, if I may say so, of over secretion of the cerumen and of desquamation of the epidermis. Dr. Guye (Amsterdam) however, maintains that in these cases there is actually a diminution in the quantity of the cerumen secreted, but that the secretion is altered in character so that it is not readily removed in the natural way by the movement of the jaw, and thus it accumulates.

If this accumulation occurs at or after middle life it is liable to come again and again so that the obstruction has to be removed every three or four years or possibly much oftener.

Diagnosis.—As a rule the patient gives a history of recent very marked deafness, coming on suddenly, often worse after lying down and better after getting up, this improvement being preceded by a sensation of cracking. On examining with the speculum the tube will be found to be filled, more or less completely—with cerumen, the colour of which varies from a shiny black to a pale brown. I should perhaps here again caution the student that this examination requires some care, for if the speculum

be not properly directed one is liable to mistake a piece of wax lying on the floor of the meatus for a complete obstruction.

As a rule the diagnosis is easy; but occasionally a small layer of cerumen lying on the membrane (called sometimes a *face plug*) may be difficult to make out, either on account of its blackness absorbing the light, or because its shiny appearance renders it liable to be mistaken for the membrane itself. In the first of these cases a change of light, such as from daylight to artificial (electric light is the best) will clear up the difficulty; and in the second, in addition to this, careful search should be made for the handle of the malleus; if that can be discerned, the object in view is undoubtedly the membrana tympani.

Another deceptive appearance may be produced by a thin layer of dry cerumen stretched across the meatus, producing what is called a *false membrane*. This frequently has a small opening in it which may readily be mistaken for a perforation of the membrana tympani. To make certain we should examine its position, note whether it is too near to the opening of the meatus to be the membrane, and look out for the handle of the malleus. Again, with a mop of cotton wool, or by syringing, we can readily break it up if it be a false membrane, and then the true membrana tympani will be revealed some distance beyond.

Treatment.—Removal by syringing is the proper treatment. If, however, the plug is very hard, it should be softened beforehand by means of warm instillations of plain water, of oil* or glycerine and water. Undiluted

* Many surgeons object to the use of oil as it favours the growth of fungi. But this objection does not hold good in this country, as parasitic inflammation of the meatus is almost unknown here.

glycerine should not be used, because it occasionally produces inflammation. The instillation should be used twice a day for three or four days before the syringing. By softening the plug, the operation is rendered far more easy to the surgeon and much less disagreeable to the patient.

This softening is much more important where inflammation has been set up, and in such cases it is well to reduce the inflammation by means of counter-irritation, etc., before syringing is attempted.

Form of Syringe.—I prefer a two-ounce brass syringe this purpose. The nozzle must be fine but it is well

FIG. 21.—Nozzle of ear syringe.

to have a rounded tip so as to prevent injury to the meatus (see fig. 21). Most of the ear syringes have very bad nozzles, being much too large, thus blocking up the meatus to such a degree that the return current is obstructed.

Mode of Syringing.—Having quite filled the syringe (without allowing any air to enter) with pleasantly warm

water, and having placed a small basin under the ear, the surgeon should straighten the meatus, drawing the ear outwards with a little twist. The fine jet of water from the syringe should then be directed so as to pass between the wall of the meatus and the plug, and *not* in the direct central axis. By this means, the water strips the plug from the meatus and the return current drives it out. The syringe may have to be used several times before the plug is detached, and the surgeon should not be content with syringing only at one spot but should work right round the obstruction.

The best form of basin is that made of glass with a partition across it so that when held under the ear the further side can be filled with clean water for the syringe, while the other will catch the return flow as it comes from the meatus. A similar basin may be made in tin and answers equally well; but failing these, the bottom of a soap dish makes a good substitute as far as catching the water is concerned, while a second basin may be used for the clean water.

In syringing the amount of force applied must be regulated by the amount of obstruction, and after this has been removed, care should be taken that no force is used lest the membrana tympani be exposed to undue pressure.

When the water comes out quite clean the surgeon may conclude that the whole of the obstruction has been removed, or if the end of the expelled plug displays the cast of the membrane, that will indicate the same thing. However, it is not wise to wait for these indications, but the ear should be examined from time to time during the operation.

If the ear of the patient begins to feel tender from the syringing before the obstruction is removed, it is

best to desist immediately and continue the softening process for a few days longer. Otherwise inflammation in the ear may be set up, and this will be increased by the plug acting as a foreign body.

After the removal of the plug and when the ear has been carefully dried, a small piece of cotton wool should be inserted and kept in for a few hours to prevent cold.

Sometimes the syringing will produce giddiness from disturbance of the semi-circular canals; or again, it may produce fainting even when no pain has been felt. However, these two disagreeable results may be generally avoided by having first softened the plug.

It is well to warn patients that, during the softening process, the swelling of the plug and presence of the fluid may make them temporarily deafer; otherwise finding that the treatment is apparently making them worse, they lose confidence and refuse to come again to have the plug removed.

Before dismissing the subject of syringing I would urge upon my readers the necessity of learning the knack of doing it properly, an art which requires much practice; for occasionally a plug cannot be removed without the greatest possible dexterity.

The use of other Instruments.—When the plug consists chiefly of cerumen no other instrument should be used except the syringe; but when the obstruction is made up entirely or almost entirely of epidermic layers, the syringe will frequently fail to remove the mass without the assistance of other instruments.

In such cases a flattened (not sharpened) probe and a pair of fine forceps may be used. But these two must never be employed without thorough illumination of the meatus, so that the surgeon is able to see everything he is doing, and even then extreme care is re-

quired. In fact the removal of the laminated masses is sometimes the work of several sittings.

I may here mention that occasionally we meet with a localised patch of chronic dermatitis with desquamation, when the surface becomes covered with epidermic layers. Should the patch be situated on the membrana tympani it is liable to produce very distressing tinnitus.

In these cases it is not only necessary to remove the scales, but also to stop further desquamation. This is sometimes a difficult matter, but may usually be accomplished by painting the denuded surface from time to time with a solution of nitrate of silver (gr. xxx. to ʒ i), or with diluted nitrate of mercury ointment.

Sometimes after an obstruction has been removed the patient asks for advice as to how the ears should be cleansed; thinking, as many do, that the presence of this accumulation indicates want of cleanliness. The surgeon should explain that such is not the case, and that the ears should never be cleaned out further than can be reached by the finger covered with a towel, and that all aurilaves and ear-cleaners are worse than useless. In fact very often the surgeon will perceive from the polished nature of the surface of the plug, that the patient has hastened his deafness by pushing the cerumen on to the drum by some such means.

Occasionally, as already stated, we have a plug complicated with inflammation of the meatus. Sometimes the plug, acting as a foreign body, produces so much irritation that inflammatory polypi are formed in front of it so as to hide it completely. Again, the swelling of the meatus in front is often sufficient to hide it from view. These cases are liable to puzzle the surgeon and lead him to a very erroneous diagnosis and prognosis.

The inflammation and polypi should be treated as

laid down later on, and as soon as the former has quite subsided the plug should be removed, taking care not to attempt this until it is quite soft.

Foreign bodies.—A great variety of foreign bodies have been found from time to time in the meatus.

For practical purposes they may be divided into three classes :—

1. Those that are liable to swell and enlarge, thus becoming firmly impacted and the source of serious irritation; such as peas, beans, seeds of the locust bean, coffee berries, etc.

All these are apt to swell and germinate in presence of the warmth and moisture around them, and, by irritating the surrounding parts, to set up inflammation. This may extend through the upper wall of the meatus to the meninges of the brain, and result in fatal meningitis even without perforation of the membrana tympani.

2. Those foreign bodies that are liable to irritate but which do not enlarge to any extent; such as some insects, pieces of cotton wool becoming putrescent from pre-existing discharge, etc.

3. Foreign bodies which do not enlarge and which in themselves are not liable to irritate; such as beads, shells, cherry stones, slate pencil, small pieces of wood, etc.

A foreign body may remain in the ear without producing any distressing symptoms for years; but those belonging to Classes 1 and 2—especially Class 1—are very liable to produce inflammation, or if there is the least irritation, to seriously aggravate it. Those in Class 3 are less likely to do so; and indeed, they often remain in the ear without producing any serious effect for a very long time. Only recently I removed a cherry stone quite easily by syringing it from the ear of

a man of sixty, who assured me that it had been in since he was five years of age, his parents having objected to have it touched, because a surgeon, in attempting to remove it with instruments, had pushed it further in. It had never caused him any trouble.

Foreign bodies are generally found in the ears of children who have pushed them in while playing, or while trying conjuring tricks that they have seen performed, such as passing objects from ear to ear.

Diagnosis.—As a rule this is sufficiently easy, the speculum and a good light revealing the presence or absence of a foreign body. For it must not be forgotten that many patients ask for the removal of one when there is none there to remove; especially are some elderly persons thus deceived, mistaking a form of tinnitus for the presence of an insect or other foreign body.

Sometimes the obstruction is so covered in cerumen that its nature cannot be made out until after removal. Again, not infrequently, the inflammation has caused so much swelling as to hide the substance. Or there may be a fringe of inflammatory polypi produced by the irritation which hides the foreign body. In these cases the diagnosis may be difficult until the inflammation has been reduced.

Treatment.—There are very few cases in surgery in which the operator is more likely to be led astray than when trying to remove foreign bodies from the meatus. The temptation to use the probe, scoop, or forceps is almost too great to be resisted, and yet if these are used (and they generally are) without perfect illumination the meatus is almost certain to be injured and inflamed, while the foreign body may be only driven further in. A few years ago a case of this kind occurred where so

much injury was done that the patient died of meningitis produced therefrom.

In ninety-nine cases out of a hundred a foreign body can be removed by syringing unless it has become impacted by swelling, and this rarely occurs at first. But this syringing may require considerable skill. The meatus must first be straightened by traction of the auricle (see page 61) and then the stream of warm water should be directed between the wall and the foreign body, so that getting behind it may drive out the obstruction with the return current. If the surgeon does not succeed directly and there is no inflammation he should desist and make another attempt later on.

Should there be cerumen gluing it in, as it were, this must be softened by means of glycerine and water or oil. But if this is the case and it belongs to Class I of foreign bodies, the risk of swelling must also be taken into account. The operation of syringing is much facilitated by placing the patient under the influence of an anæsthetic, more especially when dealing with a nervous child.

But suppose all attempts at removal by syringing have failed, what is to be done? Most emphatically do I answer, "Then let none but an experienced surgeon undertake its removal." The method should be as follows. The meatus being well illuminated must be first carefully examined. If the foreign body is found adhering by means of coagulated blood, etc., to one side, it must be loosened by using a flattened probe as a lever, and then it may be syringed out. If, however, it is impacted by the swelling of its own substance or by that of the walls of the meatus, other means must be adopted. Many ingenious forms of forceps, etc., have been devised; Dr. Guye's, which are like miniature

obstetric forceps, are perhaps the most useful (see fig. 22). Sharp pointed hooks of various forms are recommended, but I consider them all too dangerous for use, remembering, as we must, that the meatus is not a tube which can be pulled about with impunity. Simple blunt hooks, however, are often of use when the body has reached the outer part of the meatus.

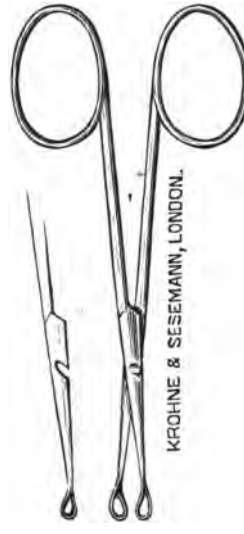

FIG. 22.—Guye's forceps with separable blades.

Another very valuable instrument for this purpose is an ingenious little blunt hook devised by Sir Joseph Lister. The shape is seen in fig. 23. It will be noted that the rectangular hook is flattened and curved from side to side, so as to adapt itself to the curvature of the meatus, and pass readily between it and the foreign body.

In cases where this is to be used the patient should

be put under anæsthetics. The instrument should then be introduced with the convexity of its hook towards the posterior wall of the meatus, care being taken that as good an illumination as possible is kept up.

When the foreign body is reached, the instrument

FIG. 23.—Lister's hook.

should be insinuated between it and the posterior wall of the meatus, the surgeon pressing rather more against the wall of the meatus than on the body, so as to avoid pushing it further in. As soon as he has passed it, (which may be ascertained by gently rotating the hook), the hook is to be turned about 40°, and in this position it is now of course behind the obstruction. Then

traction must necessarily bring out the foreign body; or, as sometimes happens, it will be cut in two, and then it may be readily syringed out. Care should be taken to prevent bleeding as much as possible, both because this will immediately obscure the view, and because it indicates more or less laceration of the meatus.

When a fringe of inflammatory polypi has grown in front of the foreign body it is generally necessary to remove that before commencing; after this the ear should be syringed out with dilute perchloride of iron, to clear away the blood and arrest further bleeding.

Although I consider Lister's hook a most valuable instrument in practised hands, it is at the same time a very dangerous weapon if not used with the utmost care.

Many other ingenious methods have been devised for extracting foreign bodies, but I cannot refrain from again insisting that the surgeon should use none of them until syringing has had a fair trial; and that whatever means are employed, the utmost care and delicacy of touch are absolutely needful.

There is one little exception to the universal rule of syringing, and that is in cases of impacted wool. Here with good illumination the forceps may be used, and on account of the clinging nature of the substance, it is very readily removed.

Diseases—**Inflammation of the Meatus.**—This may be divided into *circumscribed* and *diffuse.*

Circumscribed inflammation or furunculosis is a very common disease affecting the cartilaginous portion of the meatus.

Cause.—The same conditions which produce boils in other parts of the body may produce them in the meatus; but, except when they result from diabetes, change of

diet, debility or such like, it is not known with accuracy what those conditions are. Dr. Löwenberg of Paris has, however, thrown some light on the subject by having discovered certain minute organisms in the contents of the boil, which no doubt will account for the great tendency there is to recurrence.

Symptoms.—As a rule there is intense pain, sufficient to keep the patient awake at night. But the degree of pain depends not only upon the amount of inflammation, but also upon its site, for when very superficial there is little or even none. If, however, it is deep-seated, and especially if the fissures of Santorini become involved, the pain is extreme; the reason being that here the tissues are very rigid, and thus free swelling being interfered with, the nerves are subjected to greater pressure. According to Löwenberg the sebaceous glands, into which the organisms have found their way, form the seat of the disease.

When the swelling is very great, the meatus becomes blocked and gives rise to a considerable amount of deafness, which generally passes away as soon as the swelling is reduced sufficiently to allow a free passage along the meatus. Should, however, the deafness remain after the swelling has gone down, it may be found that this results from accumulation of discharge blocking the way.

On examining the ear one or more swellings are usually noticed protruding into the meatus; but if, as frequently happens, these are situated close to its entrance and are not large, they may easily be overlooked until the pain produced by the pressure of the speculum calls attention to them.

Sometimes the swelling is so prominent as to be mistaken at first sight for a polypus; but it may be

readily diagnosed from this by its broad base, which is easily recognised if the surgeon attempts to pass a probe round it.

After a few days pointing and rupture, or sometimes resolution, or still more frequently semi-resolution, take place and the swelling goes down; in the last case, only to return again after a short time.

When the furunculus ruptures of course there is a slight discharge in the meatus, then the swelling disappears and the patient recovers. There is, however, a very great tendency to return, and a patient may have three or four attacks following each other at intervals of perhaps a fortnight.

Treatment.—Early incision so as to deplete the part even if pus has not already been formed, gives great relief and may arrest the disease. Counter-irritation in the form of a blister behind the ear also gives relief and tends to reduce the inflammatory swelling; while, if the pain is very severe, a couple of leeches should be applied in front of the tragus. Poultices and hot fomentations are of great service, but these must not be continued after the pain has disappeared; when poultices are used they should be encased in muslin so that they may be removed entire.

As soon as the discharge makes its appearance, warm injections, either of warm water simply or containing a little carbolic acid or other disinfectant, are advisable.

Again, if there is considerable discharge with pain, a warm lead and morphia injection, (liq. plumb. and liq. morph. āā ℥ j, water ℥ x, m., ft. inj., one tablespoon to a wineglass of warm water) will be serviceable.

When all the acute symptoms have gone and the swelling has nearly disappeared, means for the preven-

tion of a return should be employed; and for this purpose I make use of some dilute mercurial ointment, as for instance (ung. hyd. nit. ʒ j, vaseline, and ol. amygd. āā ℥ j). This is to be painted into the ear with a camel's hair brush two or three times a day, taking care to line the whole of the cartilaginous portion of the meatus with the ointment. This treatment, whether by causing absorption or by destroying Löwenberg's organisms, will in most cases prevent a return.

The patient's general health must not be overlooked; tonics, etc., often being required.

It is well to warn the patient of the tendency to recurrence of the disease; otherwise should it return he may consider that the surgeon has not properly treated the case.

DIFFUSE INFLAMMATION, ACUTE AND CHRONIC.—**Acute.**—The most frequent cause of this condition is bathing, the cold water getting into the meatus and setting up inflammation. Sea-bathing is especially liable to produce it, on account of the waves. Wounds and foreign bodies also induce this condition.

Symptoms and Signs.—Pain in the meatus, varying considerably in amount, and tenderness on pressure over the tragus. Discharge generally appears sooner or later. On examining the meatus considerable swelling of the walls will be noticed; and this is more frequently found affecting the osseous than the cartilaginous portion. Deafness, varying in degree according to the amount of swelling and discharge and the consequent interference with the membrana tympani.

In severe cases the tympanic cavity is involved, and perforation of the membrane takes place, this complication being indicated by the signs of perforation and by tenderness on deep pressure under the auricle. But, as

a rule, it is unnecessary and very unwise to meddle too much with the meatus for the purpose of making a full examination.

On account of the intimate connection of the skin and periosteum in the osseous meatus, acute inflammation of this part is very liable to be complicated with acute periostitis and ostitis, which is indicated by polypoid granulations growing from the inflamed spot. And should this inflammatory condition extend inwards, meningitis may result. This is more likely to be the case when the bone forming the roof of the meatus is the part involved.

Treatment.—Counter-irritation in the form of blisters behind the ear, leeches in front of the tragus, hot fomentations, purgatives, and soothing injections or instillations form the most valuable modes of treatment. Injections, except soothing ones, should not be used; one of the most serviceable of these is the lead and morphia injection (see page 71). Solutions of morphia (gr. ij to ʒ j), or of atropine (gr. j to ℥ j), used quite warm, make good instillations. If the pain prevents sleep hypnotics are advisable. When cerebral complications are threatening absolute rest and quiet are indispensable.

After the more active symptoms have passed away insufflations of finely powdered boracic acid may be employed; and if any polypoid granulations exist, they should be touched with nitrate of silver.

Acute inflammation is generally followed by a chronic stage of the disease.

The *prognosis*, as regards the hearing power, is usually good unless the tympanic cavity has been involved, and even then perfect recovery is frequently obtained.

Let me here mention that it is well to warn all persons liable to disease of the ear against bathing, especi-

ally in the sea, without some protection to the ears; the best safeguard is afforded by putting a large piece of cotton wool in both ears, and wearing an oilskin cap fitting tightly over them.

Chronic Inflammation.—Chronic inflammation of the meatus, or external otorrhœa, is usually a sequela of the acute form.

The signs and symptoms consist of a certain amount of deafness with purulent discharge. The absence of a perforation of the membrana tympani is sufficient to distinguish between this condition and chronic suppurative catarrh of the tympanum (see page 113).

Treatment.—This is the same as for simple cases of internal otorrhœa (see page 117), and consists of injections and insufflations.

The *prognosis* is favourable.

Eczema.—Acute and Chronic.—*Acute eczema* of the meatus, and indeed of the concha, is very common in badly fed infants, especially during teething. In these cases there is generally a profuse watery discharge, not infrequently tinged with blood; and this discharge, escaping on to the surrounding surfaces, sets up an eczematous condition.

As a rule it is impossible to make sure that there is no perforation in these infantile cases without producing increased irritation of the parts; but wherever a diagnosis can be readily made the surgeon should make one, following the rules on p. 113.

The deafness is usually very marked because the surface of the membrana tympani is more or less involved in the general eczematous condition.

Treatment.—Attention to proper feeding and to the general health is absolutely necessary. Mild injections, such as dilute liq. plumbi, may be used for cleansing the

meatus, the surfaces of which should then be lightly painted with some ointment such as vaseline, ung. diachyli (Hebra's ointment), ung. zinci and ung. acid. borac. All friction must be avoided and no soap allowed to touch the parts affected.

In inveterate cases ulceration of the skin may take place, and then the following treatment is advisable. After thoroughly cleansing with a warm water injection, the surfaces should be painted with a strong solution (ʒ j to ℥ j) of nitrate of silver, and then covered with boracic acid ointment. The caustic application may be required two or three times at intervals of twenty-four or forty-eight hours.

Acute eczema, when it does occur in the adult, has to be treated locally in the same manner, and any predisposing constitutional cause must be removed as far as possible by appropriate internal remedies, alteration of diet, etc.

Chronic eczema.—This is a condition that is more frequently found in adults. The meatus presents a somewhat swollen, or it may be a very much swollen appearance, with a more or less glazed and cracking surface; and frequently the auricle is also involved. The ear is often so irritable that the patient cannot refrain from rubbing it. There is a slight watery discharge, and the deeper portion of the meatus is often filled with débris of the desquamation. The hearing will not be affected unless the swelling or the débris be sufficient to block the meatus or cover the membrana tympani.

Treatment.—Unless the case is severe and of long-standing suitable injections and ointments are generally sufficient to effect a cure in a week or two, but in some instances there is a great tendency to return. Ointments of a somewhat stimulating nature are to be preferred, and

of these I consider some form of mercurial application to be the best. Diluted nitrate of mercury ointment (see p. 72), is very good. Occasionally some form of tar ointment is still better. This must be applied with a camel's hair brush so as to prevent any rubbing, and the surfaces kept constantly moist by using the application three or four times a day.

Injections of warm water, warm milk and water, or a solution of sulphate of zinc may be used more or less frequently, according to the amount of débris to be removed.

When the case is severe or of long-standing, with much thickening of the integuments, then constitutional treatment becomes necessary. Arsenic in the form of Fowler's solution (♏v three times a day, after food), should be tried, as it generally yields very satisfactory results. Of course care must be taken that no arsenical irritation is produced, and in those cases where ordinary doses are not tolerated, minute ones will be found to act very beneficially. The patient should be advised not to wash the parts with soap, as this is liable to cause irritation.

Inflammation from Presence of Fungi.—Occasionally the meatus is the seat of inflammation due to the presence of microscopic fungi. Several forms of these have been described, but the chief among them are the aspergillus nigricans and the asp. flavescens.

Although this condition is exceedingly rare in England it is said to be common enough in some parts of Continent, and to be occasionally met with in the United States; our immunity being due probably to the greater attention paid to cleanliness by the lower classes in this country. I will here quote the description of it from Cassell's translation of Professor Politzer's work (p. 613).

"The subjective phenomena of parasitic otitis externa are great itching, and flying stitches, which increase to violent pains radiating towards the head and throat. In most cases tinnitus and deafness are superadded.

On examination of the meatus in cases of A. nigricans, the osseous section especially and the membrana tympani are found covered with a black-spotted or entirely black membrane, having the appearance of being strewn with fine coal-dust. On syringing it is washed out in shreds of considerable thickness, on the surface of which the characteristic black spots (sporangia) are visible either with the naked eye or with a lens. According to Löwenberg, the epidermis permeated with mycelium may take the form of small cysts, on the inner surface of which the fungous growths are seated. In cases of A. flavesc., the surface of the epidermis invaded with mycelium appears covered with a yellowish mass of dust, like the powder of lycopodium.

After removal of such membranes from the meatus, the lining membrane of its osseous section and the membrana tympani are found very red, swollen, and in great part devoid of the epidermic layer. Here and there, however, are seen solitary, irregular grey islands, on which, after removal with the probe, epidermic cells mixed with fungous spores are recognised."

"*Course and termination.*—The course of parasitic otitis externa depends upon the extent of the fungous growths and the time treatment commenced. When the affection is left to itself or treated by a physician who does not know its nature, the inflammation may continue for several weeks without the least abating, and as I have observed in several cases, may lead to perforation of the membrana tympani from without inwards. In many cases the inflammation ceases, notwithstanding the pre-

sence of fungous growths in the ear, only to re-appear with renewed vigour at intervals of weeks or months. On examining such cases the meatus is very often found filled with fungous membranes closely packed.

Immediately after removal of the membrane in the inflammatory stage, there is a decided diminution of the pain and of the subjective noises, speedily followed by cure on proper treatment being employed. When, however, after the removal of the fungous membrane no antiparasitic remedy is used, on the following day, even in cases in which the reactive symptoms continue, the meatus is often found re-covered with a thick fungous membrane similar to what had been already removed. Such rapid recurrence may go on till either the fungus becomes exhausted or treatment effects a cure."

"*Diagnosis.*—The diagnosis of fungous growths in the meatus presents no difficulty when with decided symptoms of otitis externa, the characteristic appearance of the meatus is found on examination with the speculum. Sometimes, however, brownish-black epidermic plates are syringed out of the ear, on which the brown covering appears as dust, coal-dust, or vegetable débris, which might be mistaken for those fungous membranes. In doubtful cases, therefore, microscopic examination is indispensable before giving a diagnosis."

"*Prognosis.*—The prognosis of otitis externa parasitica is in all respects favourable, as by the use of parasiticides a rapid cure is effected, and, even after perforation of the membrana tympani, cicatrization of the aperture speedily follows (*cf.* Bezold on *Otomycosis*, 1880). The prognosis is not so favourable, however, where there is the possibility of a recurrence of the inflammation, particularly in persons who live in damp, mouldy localities, in which the cause of a renewed attack is always

present. I have also seen frequent relapses in persons in the most favourable circumstances without apparent cause."

"*Treatment.*—Of the numerous remedies recommended for the removal of fungous growths, rectified spirit, recommended by Hassenstein and Küchenmeister, has proved the best. It is used as follows:—After the fungous membranes have been nearly all removed by syringing, the meatus is filled by means of a warm spoon with rectified spirit, which is kept in the ear for at least a quarter of an hour. This procedure is at first to be repeated twice daily. As a rule the spirit can be well borne. When it causes a burning feeling, it is advisable at first to dilute the spirit with distilled water, and gradually to employ concentrated spirits of wine.

The result of the treatment is so quick, that even after two days no sign of fungus is visible in the meatus. The lining membrane of the meatus and the membrana tympani appear covered with a fine dry epidermis; pain, tinnitus and deafness disappear, and after three or four days' treatment the cure is almost complete."

Gouty Inflammation.—Gouty patients are occasionally liable to inflammation of the meatus.

This should be treated as an ordinary case of inflammation together with constitutional treatment of the gout itself. Counter-irritation behind the ear, injections if there is a discharge, aperients containing colchicum, free use of diluents together with bicarbonate of potash, are in all such cases very serviceable.

Syphilitic Inflammation.—Syphilitic inflammation is very rare but it does sometimes occur, and then we may get a fringe of condylomata round the meatus.

It must be treated locally and constitutionally as when it occurs elsewhere. An injection of black wash is strongly to be recommended.

Tumours.—Polypi growing from the walls of the meatus are generally due to periosteal inflammation, but occasionally we meet with true myxomatous and fibrous polypi. For treatment see p. 134.

Exostosis.—Exostoses of the meatus are found somewhat frequently, and these may be divided into three varieties.

1. Multiple, rounded and polished on the surface, and consisting of dense compact bone.

These are generally met with among well-to-do patients, especially in those suffering from a gouty diathesis. They may be of any size from that of a millet seed to that of a small pea. They grow very slowly and when approaching so as to touch each other their growth appears to be slower still. It is very rare for the meatus to be completely occluded by them, but they render it liable to obstruction by even a very small amount of cerumen or débris.

There is a considerable difference of opinion as to the cause of these bony growths, some surgeons believing them to be due to bathing, others to syphilis, etc.; but in my opinion they are usually the result of gouty, or in some cases perhaps rheumatic, irritation of the periosteum.

2. Multiple, but irregular in shape, with broad bases consisting of dense compact bone.

These are due to irritation of the periosteum from old-standing otorrhœa, or occasionally, from ossification of polypoid growths; they increase in size slowly though somewhat more rapidly than those of the first class; and on account of this freer growth, there is rather more probability of occlusion of the meatus. When much occlusion does take place a very serious condition is the result, on account of the opposition to a free exit

for the discharge; and this is still graver when any caries or necrosis exists.

3. A single polypoid exostosis, due to ossification of a fibrous polypus; consisting of very dense compact bone in the centre, fibrous tissue on the outside, and cancellated bone projecting from the central portion into the fibrous tissue.

It is a very rare form and may exist without any signs of even former otorrhœa. This variety tends to enlarge much more than either of the others, and sooner or later will completely occlude the meatus.

Diagnosis.—At first sight exostoses may be mistaken for polypi, but those of the first variety may be easily recognised by their rounded and polished appearance. The use of the probe will reveal the hardness of the mass and so clear up the diagnosis.

The effect on the hearing power is usually nil; except as already noted, when a small quantity of cerumen or scales causes complete occlusion, and then of course marked deafness results. The same will be the case when in the third variety, the exostosis has grown sufficiently to block the meatus.

Treatment—As a rule the exostoses of the first and second class require no treatment for themselves, but the cerumen may have to be removed from time to time by the syringe; and in the second class, the otorrhœa must, if possible, be healed, so as to prevent continued growth and serious occlusion of the meatus. Should, however, such occlusion take place, especially when carious disease exists beyond, then operative interference becomes necessary. .

In exostoses of the third variety, removal should be undertaken as early as possible; and then on account of the polypoid shape, it is not a very difficult operation.

A dentist's elevator or a special gouge inserted between it and the wall near the pedicle, will enable the surgeon to break it off; but if it is very large there may be some difficulty in doing this. Should such be the case the use of an injection of dilute nitric acid (half per cent. to one per cent.) continued for several weeks will frequently soften the outer portion sufficiently to allow of the foregoing operation.

In the few instances of the second variety where it is necessary to remove the exostosis, the dental drill worked by the dental engine is the best means of doing so. The handles of the burrs for this purpose, should be longer than those used by the dentist.

The operation of drilling these exostoses is always tedious, on account of the extreme hardness of the bony tissue, and it may take two or three sittings to remove enough of the obstructing mass. A dentist should work the machine while the surgeon very carefully guides the perforating point. Mr. Field uses a metallic shield, made for each separate case, to prevent the point from penetrating in a wrong direction.

I have successfully removed a tumour of this kind by drilling it in two places and then making use of injections of dilute nitric acid as before mentioned. The acid destroying the exostosis, it came away piece-meal and was thus entirely removed.

But I would here impress upon the reader that operations for the removal of exostosis are very rarely advisable, and should never be undertaken lightly; although in certain serious cases, as for instance where we have occlusion with inflammatory mischief beyond, it is most important to remove the block if only to allow a freer outlet for the discharge.

The late Dr. Cassells of Glasgow and some other sur-

geons, have recommended the use of the hammer and chisel for the purpose of removing these growths.

It is a curious fact that the skulls of certain aborigines of America, frequently present extensive exostoses of the meatus, but the cause of this peculiarity has not yet been satisfactorily determined.

CHAPTER V.

INJURIES AND DISEASES OF THE MIDDLE EAR.

INJURIES.—Rupture of the membrana tympani may be produced in two ways; first, by directly wounding it by means of some more or less pointed instrument; second, by explosions.

Wounds.—Hair-pins, pencils, penholders, matches, spectacle arms, etc., pushed into the meatus may produce the wound. If the rupture is in the lower half of the membrane, the injury to the hearing may be exceedingly slight, and provided there is no inflammation produced, the perforation will heal rapidly. In these cases a piece of cotton-wool should be kept in the meatus, and a strictly expectant treatment followed.

If the perforation is in the upper part of the membrane much injury may be done to the ossicles and their attachments, and considerable deafness will follow. These cases should be kept very quiet to avoid inflammation, and as the healing process proceeds careful inflation by means of Politzer's bag is advisable. If there is any tendency to inflammation a blister should be put behind the ear, and a purgative administered. I often blow in finely powdered boracic acid so as lightly to cover up the wound, and thus allow it to heal under the powder.

Syringing the ear should be always avoided unless a purulent discharge has already been set up.

If acute inflammation supervene, the case must be treated accordingly (see p. 73).

Explosions; including atmospheric condensation produced by blows on the ear, will occasionally bring about rupture of the membrane, but more often these accidents merely produce displacement of the membrane and ossicles. From personal experience I have come to the conclusion that blows on the ear and explosions (excepting from rapid explosives as gun-cotton and nitroglycerine compounds), rarely or never produce rupture of the membrane or any serious displacement, unless there is some amount of Eustachian obstruction.

These cases should be treated in the same way as the preceding, but there is generally more need of inflation, and as a rule, the catarrh of Eustachian tubes and nasopharynx requires attention.

To prevent these accidents, artillerymen, riflemen and sportsmen should take care to keep their tympanic cavities duly inflated (*e.g.*, by Valsalva's method), and to block the meatus with a firm plug of cotton-wool. But I do not consider this at all necessary if the middle ears are quite normal.

Perhaps it will be well here to notice the rare accident of injury to the chorda tympani nerve in the tympanum. It is just possible that it may be accidentally injured when the membrane is ruptured by direct violence; but, as a rule, when this nerve is injured it is done by the surgeon in operating for division of the membrane or in removing a polypus. When this occurs the patient perceives a pain, or it may be a metallic taste or a mere numbness, referred to the tip of the tongue and along the same side of it as the injured ear. This condition requires no special treatment.

DISEASES.—**Catarrh.**—The tympanic cavity and the Eustachian tube, being lined by mucous membrane, are subject to various forms of catarrhal inflammation.

This catarrh in nearly every case commences in the naso-pharynx, and passes up the Eustachian tube into the tympanic cavity, and sometimes also involves the mastoid cells.

Middle ear catarrh is generally divided into the following :—

1. Acute non-suppurative catarrh.
2. Acute suppurative catarrh.
3. Chronic non-suppurative catarrh.
4. Chronic suppurative catarrh.

1. **Acute non-suppurative catarrh** or otitis media without suppuration, is the usual cause of the ear-ache so frequent in infancy and childhood, although this is commonly put down to mere neuralgia.

Symptoms.—Deep-seated pain with tenderness on deep pressure below the auricle. A sense of fulness, pulsating tinnitus, and throbbing, with more or less marked febrile symptoms.

Signs.—Vascular injection of the membrana tympani, especially along the handle of the malleus, and sometimes, though rarely, bulging of the membrana tympani; deafness, more or less marked; naso-pharyngeal catarrh.

Diagnosis.—This condition may be distinguished from mere neuralgia by the congestion of the membrana tympani, and by the loss of hearing power; and from the various forms of inflammation of the meatus, by the absence of their signs as recognised by the speculum and also by the tenderness on deep pressure below the auricle. Lastly, in nearly every case there will be marked naso-pharyngeal catarrh.

Causes.—The predisposing causes are former suppurative inflammation; existing chronic suppurative catarrh; catarrh of the pharynx.

Exciting causes.—Cold; fevers, especially those affecting the pharynx as scarlet fever, measles, etc.; teething or other dental irritation; the nasal douche. This last must not be lost sight of when nasal injections are used; for, as pointed out by Dr. Roosa (New York); the fluid will occasionally enter the tympanic cavity and set up inflammation.

Treatment.—Injections of pleasantly warm water, or warm steam, or hot air injections where feasible; hot fomentations; one, two or three leeches applied just in front of the tragus are very serviceable if the pain be acute; counter-irritation such as a blister or strong mustard behind the ear.

And here it may be well to state that the patient should be warned against the use of any direct irritation in the form of stimulating instillations, which only tend to aggravate the disease. Nothing is more common than to find them applying either some form of alcoholic instillation, or pieces of roasted onion and the like; and this is doubtless the result of a mistaken idea, that the disease is neuralgic and not inflammatory.

Aperients are usually of great service, and should be given early in the attack. Diaphoretics are of some value, but their benefit is often over-rated. Instillations of morphia and atropine (see p. 73), will often give relief to the pain, but they must only be regarded as sedatives, and not as treatment of the disease itself. Occasionally hypnotics, such as chloral and opium are necessary to induce sleep when the patient is worn out by restless nights.

Perforation of the membrana tympani is strongly recommended by some authorities, but, as a rule, this is not called for unless there are signs (such as bulging of the membrana tympani) of suppuration within the tym-

panic cavity, when it ceases to be a case of non-suppurative catarrh.

Lastly, the treatment of the naso-pharynx must not be overlooked, warm mild astringent gargles being usually necessary, and at times inhalations of warm steam are very beneficial.

These cases generally end in perfect recovery; but there is always a danger of adhesion of the membrana tympani to the inner wall of the tympanum, of adhesions fixing the ossicles, or of permanent occlusion of the Eustachian tube, any of which will result in deafness. To prevent these, inflation by means of Politzer's bag should always be practised as soon as the more acute pain has passed off.

2. **Acute suppurative catarrh** is only a further development of the foregoing condition, the symptoms being the same but intensified. The pain is more acute but is generally relieved by rupture of the membrana tympani and consequent discharge of pus. This rupture may occur within a few hours of the seizure, or, more frequently, after the pain has lasted two or three days. If the membrana tympani is examined before this takes place a bulging and excessive congestion of the membrane may be noticed; if examined after, the meatus will be found filled with pus. When this has been gently syringed away pulsation of the pus filling the ruptured spot may almost invariably be seen.

The course of disease in these cases is usually as follows. The acute inflammation of the Eustachian tube causes its complete obstruction so that, when suppuration takes place the pus, not being able to find an outlet by its means into the pharynx, is imprisoned within the middle ear. Pressure is thus exerted on the membrana tympani, and bulging, ulceration, and finally rupture result.

The causes are the same as for the non-suppurative variety, but the exanthematous fevers tend much more to produce this suppurative form.

Although for the sake of clearness of description it is necessary to speak of inflammation of the tympanum as distinct from that of inflammation of the adjacent parts, and to distinguish between the suppurative and non-suppurative varieties, it must be borne in mind that in reality the course of disease is not confined within any such limits and that, as a matter of fact, the most frequent cases which come before the surgeon are those where acute non-suppurative inflammation is followed by the acute suppurative, and in which not only the tympanum but the meatus itself is involved. For example, the general aspect of the case may be as follows:—

A patient complains of severe earache coming on after a bad cold and sore throat, and inability to sleep for the last two or three nights in consequence of the pain; also of much throbbing and tinnitus, a sense of great fulness in the ear and in the affected side of the face, marked deafness, and a discharge which had followed after a sense of rupture, producing a certain amount of relief from the pain.

On examining the patient there will be found a slight general swelling in the region of the ear and considerable tenderness on pressure in front and below the auricle, or indeed upon any movement of the auricle or of the lower jaw; also profuse discharge from the meatus with partial occlusion from swelling of its walls. This swelling and tenderness should entirely preclude the use of the speculum; for while it can do no good, as no view of the membrane is possible under such circumstances, its introduction would only increase and aggravate the pain and inflammation.

An examination of the pharynx will show signs of acute catarrh either present or recently passed off, while increase in temperature and rapidity of pulse denote general febrile disturbance.

Treatment.—The treatment is the same as for the non-suppurative variety but should be more energetic.

FIG. 24.—Perforator for the membana tympani. A. Broad view of point.

Leeches in front of the tragus in the very acute stage will give great relief, and I always put a small blister behind the ear unless it is contra-indicated by the gene-

ral exhaustion of the patient, as sometimes happens when this disease occurs in the course of scarlet fever, etc.

If the case be seen early enough, and there is no swelling of the meatus, puncture of the membrana tympani should be performed, especially if any bulging of the membrane is visible. This is done by means of a perforator such as shown in fig. 24, and with the aid of a good light thrown on the membrana tympani so that the surgeon can see exactly what he is doing. Moreover, the operation ought to be performed, if possible, by a practised hand. The puncture should be made below and behind the handle of the malleus unless there is bulging in some other part, in which case that spot should be chosen for perforation.

In very acute cases, where leeches fail to relieve the pain, a vertical incision should be made on to the mastoid process, about half an inch long and half an inch behind the auricle, care being taken to divide the periosteum. If the hæmorrhage is smart, the relief will probably be great. This incision acts by more directly depleting the inflamed part.

Prognosis.—This is not so favourable as in the non-suppurative variety, though far more so than is generally supposed; for an uncomplicated acute attack in the majority of cases terminates in complete recovery. But when this affection occurs in the course of scarlet fever, measles, etc., the prognosis is not nearly so good, on account of the greater destruction of the parts and greater tendency to the formation of adhesions, etc., from the continued febrile condition.

Results.—Recovery, with complete or partial restoration of the hearing power; chronic suppurative catarrh; mastoid complications; periostitis and ostitis; necrosis and caries; meningitis; abscess in the

brain; pyæmia. All these sequelæ will be treated of in due course.

Recurrent acute catarrh.—Patients, especially young children, suffering from chronic non-suppurative catarrh of the naso-pharynx, etc., may be subject to recurrent attacks of acute catarrh, suppurative or non-suppurative.

Such cases should be treated during the attack as already indicated, but if nothing further is done the recurrence will continue; it is therefore necessary to treat the chronic catarrh of the pharynx, Eustachian tube and tympanum, so as to prevent this. When this is done the prognosis is very favourable. Occasionally we get recurrent attacks of acute inflammation which are due to smouldering disease of the bony walls. Then repeated blistering together with attention to the general health will, as a rule, overcome the disease.

CHAPTER VI.

DISEASES OF THE MIDDLE EAR—*(continued).*

Chronic non-suppurative catarrh.—This is perhaps the most common cause of deafness and becomes less and less amenable to treatment as time goes on, and the age of the patient increases.

This disease may practically be regarded as an extension of catarrh from the naso-pharynx. Of the numerous forms of chronic catarrh to which the naso-pharynx is subject, the following are the most important:—

1. *The simple relaxed catarrh.*—Here the mucous membrane is more or less thickened, and in colour a dull leaden red; but sometimes the swelling is greater and the colour brighter, then it is often called red catarrh.

2. *Dry Catarrh.*—In this variety the mucous membrane is drier than it should be, the patient often saying that he never uses a handkerchief, and that hearing is improved during the running stage of a cold. Sometimes the mucous membrane is so dry that it presents a glazed appearance.

It would appear that whereas the former variety is more common in damp cold climates like our own, the dry catarrh attacks people living in hot dry countries; hence it is often met with in parts of the United States.

3. *Granular Catarrh.*—When this exists small elevations, in size and shape like the millet seed, are scattered over the mucous membrane, these elevations being

usually of equal size. Leading to and from these the small vessels are seen to be greatly enlarged, giving the mucous membrane an injected appearance; this congestion produces catarrh, and some thickening of the mucous membrane. The granulations are mere hypertrophies of the normal adenoid tissue of the parts, or in other words, enlarged blood glands. Such a condition is very liable to produce Eustachian and tympanic catarrh by extending along the Eustachian tube, which, in its cartilaginous portion, is freely supplied with such glands.

4. *Adenoid Catarrh.*—This variety closely resembles the last pathologically, as has been pointed out by Dr. Meyer (Copenhagen),* but it is very different in appearance on account of the greater size of the adenoid masses. The mucous membrane of the naso-pharynx, in this case, is studded with small irregularly shaped adenoid tumours, of a size varying from that of a hempseed to that of a horse-bean, or even larger. These are, as a rule, completely adherent by their broad surface to the mucous membrane, but occasionally they become pendulous and polypoid. Again, very often the diseased tissue assumes the form of a thick cushion, lining the sides and posterior wall of the naso-pharynx. These tumours of adenoid tissue are most commonly met with in young children, and usually diminish in size as age advances. This condition is often associated with chronic enlargement of the tonsils themselves.

Two or three of the foregoing varieties frequently exist in the same case. The simple and dry catarrh seem to belong more especially to advanced age, while the adenoid form is characteristic of early youth.

* *Transactions International Medical Congress*, London, 1881, vol. iii., p. 278; also *Medico-Chirurgical Trans.*, 1870, p. 53.

All these catarrhs and particularly the last, may be hereditary, or, it might be more correct to say, may "run in families"; and this has been perhaps the chief cause of the old broad-sweeping assertion that "deafness is hereditary."

Symptoms.—Deafness, varying considerably from day to day, worse in damp and cold weather and especially so on catching cold (except in the running stage of dry catarrh, as already noted), with a marked tendency to increase as age advances.

Even in the case of adenoid catarrh, where the masses diminish as the patient gets older, if much thickening of the tympanic mucous membrane has been produced the deafness will tend to increase. When a chronic catarrh has existed for many years the deafness becomes much more marked and the variations less frequent.

When it reaches this stage, too, the patient begins to notice that he can hear better in a noise, such as when travelling in a train, omnibus or other rattling vehicle. This peculiarity, if marked, is a very unfavourable sign.

Tinnitus, especially of a singing character or like the blowing off of steam, is a very frequent symptom, more particularly as the catarrh increases.

In some instances it is absent throughout the whole course of the disease; whereas in other cases the tinnitus occurs so early, that it is perceived even before any loss of hearing has been noticed by the patient.

Again, as the patient chiefly hears his own voice through the medium of the skull bones, (presuming that the internal ear is not affected), his voice sounds to him as if it had been produced in a box. This symptom, however, he does not notice when the disease comes on slowly.

Appearances.—On examining the meatus the observer

is first struck by the absence of cerumen and the clean polished appearance of the whole surface of the meatus and membrana tympani. But this absence of cerumen although usual in advanced cases is not an invariable condition in this disease.

The membrana tympani being too concave, we find the cone of light either replaced by a rounded bright spot or that it has disappeared altogether. The upper end of the malleus and also the short process project very markedly; and the folds of the membrane, radiating from the short process, are much exaggerated. On each side of the projection the membrane forms a deep sulcus. The membrane itself may be almost normal in appearance, but as a rule it has lost its lustre, and often presents considerable opacity. The extreme retraction or depression of the membrana tympani is due to loss of air within the tympanic cavity caused by constant absorption through its moist walls, and failure of the usual fresh supply by the Eustachian tube on account of its being blocked up with swollen mucous membrane; and so the external atmospheric pressure drives in the membrana tympani, it no longer being supported by an atmosphere of equal pressure within the tympanum.

On inflating the tympanum by Politzer's bag or other means, the membrana tympani will be more or less restored to its original position. If the disease has been of long standing, and the membrane and ossicles have, in consequence, become more or less fixed by the thickening; or again, if the membrane has become adherent to the promontory, etc., the restoration will be very slight and the improvement to the hearing power equally small. On the other hand, in recent cases, especially in children, inflation may produce a very material improvement both in the position of the membrane and in the hearing

power. Siegle's pneumatic speculum may be most advantageously used for the purpose of ascertaining the amount of mobility of the membrane. (See fig. 13).

On examining the pharynx some form of catarrh, already described, will be seen.

Diagnosis.—The appearances already noted and the effect of inflation are sufficient to make the diagnosis easy. But it is always advisable to test the patient by means of the tuning fork, (see p. 47), to find out whether there is any internal ear complication.

Treatment.—The objects to be striven for are:—

1. Reduction of the catarrh.
2. A free supply of air to the tympanum.
3. Restoration of the membrana tympani, etc., to the normal position.

For the first of these, applications to the naso-pharynx may be made by *nasal injections* of one of the following in warm solution; common salt, chloride of ammonium, borax, chlorate of potash, bi-carbonate of soda, or sometimes stronger astringents, such as tannin (see Appendix).

Gargles of stronger solutions of chlorate of potash, borax, alum, tannin, etc., are very valuable. While gargling the patient should either sit with his head thrown well back, or lie down flat so that the fluid may reach the naso-pharynx.

Paints.—Tannin, in the form of the glycer. acidi tannici, is a very useful application where there is much relaxation and thickening, and may be used when the patient is unable to gargle. Or solutions of perchloride of iron in glycerine, and sometimes solutions of nitrate of silver, may be used with advantage. In cases of adenoid catarrh I occasionally make use of a five to ten per cent. solution of chromic acid. For applying these paints a

large slightly bent throat brush should be employed, care being taken that it passes well up on each side towards the Eustachian tube.

The foregoing applications to the naso-pharynx affect the mouth of the Eustachian tube; but besides this, some further means must be adopted if we desire to treat the tube generally and the tympanic cavity.

FIG. 25.—Kerr's chloride of ammonium inhaler.

Vapours may be introduced into the tympanum through the Eustachian tube, either by means of the Eustachian catheter (which is the most perfect method), or by making the patient perform Valsalva's inflation forcibly, when the naso-pharynx is filled with the vapour. As a rule I prefer the latter method because after the patient has learnt it, he can repeat the operation as often as

may be desired, whereas if the inflation has to depend on the surgeon it cannot be done so frequently.

Many kinds of vapours are used; I prefer the chloride of ammonium fumes as produced in one of Kerr's inhalers. This is especially useful in dry catarrhs, and in moist catarrhs where there is not much thickening of the mucous membrane. The vapour of iodine combined with ether or chloroform may be advantageously used in some very chronic catarrhal affections of the tympanum (one part of ether or chloroform to three of tincture of iodine). Of this forty minims should be put into the bottom of an earthenware inhaler and then half a pint of boiling water poured upon it. The hot vapour must be then drawn into the mouth (not into the chest) and Valsalva's inflation performed by the patient. Care must be taken that the vapour is not used too hot, otherwise the pharynx will be scalded. This operation may be repeated four or five times at night and in the morning.

The tincture of benzoin (two drachms) or pine oil, etc., may be used in the same way, and in somewhat similar cases. All these vapours may be introduced by the surgeon into the tympanum by means of the catheter and Politzer's bag. One form of bag has a chamber in the tube containing a sponge moistened with tincture of iodine. Again, the following will be found to be a very simple method for introducing chloroform, ether, or iodide of ethyl vapours. Remove the tube from the Politzer's bag, pour in five or six drops of the ether, chloroform, etc.; refix the tube, and after allowing a short time for evaporation, the bag will be filled with the vapour. This may be used through the catheter or by the ordinary method of Politzerisation. There is good reason to believe that the vapours of chloroform and

ether are more readily introduced into the tympanum than atmospheric air.

Fluids, such as warm solutions of bi-carbonate of soda, chloride of ammonium and iodide of potassium may sometimes be introduced into the tympanum with benefit; but they must always be used with caution as there is some danger of setting up acute inflammation, especially in children.

Fluids may be introduced by one of the following methods:—

1. A little of the warm solution having been injected through the nose into the naso-pharynx, and the head tilted downwards towards the side to be treated, the patient by performing forcibly Valsalva's inflation, can readily drive the fluid into the tympanum.

2. Through the catheter. This should be introduced into the Eustachian tube; a few drops of the warm solution is then injected into it by an ordinary syringe, and the bag used to blow it into the tympanic cavity.

3. Through an artificial or pre-existing perforation in the membrana tympani.

The late Mr. Hinton was in the habit of perforating the membrana tympani, and then injecting the warm solution by means of a syringe which fitted closely into the meatus; thus, the fluid was driven right through the tympanum and Eustachian tube. His object was to wash out mucus from the tympanic cavity, but in my opinion it is far too rough a method to be recommended; indeed, numerous cases of injury having resulted from its use, its practice has now been almost entirely discontinued.

My own experience has led me to abstain from the introduction of fluids into the tympanic cavity altogether, except in certain very chronic cases occurring after middle life.

Use of internal remedies.—In certain cases of dry catarrh and especially in the dry catarrh of old age, the use internally of iodide of potassium so as to produce coryza, thus simulating the running stage of a cold, is very beneficial, more particularly whenever the sides of the Eustachian tube have stuck together.

It should be given in small doses (see Appendix), with some diffusible stimulant such as ammonia; it acts best if given in hot water and after meals; and its use ought to be continued for two or three weeks. The least possible coryza is all that is necessary.

Removal of growths.—Hypertrophied tonsils, whether of the common type or of the rarer strumous variety, should be removed whenever they are so large that they interfere with the free passage of air from the nose, or when the patient is liable to suppurative tonsillitis. And although enlarged tonsils cannot possibly, from their position, directly block the Eustachian tube, yet from their pressing the surrounding tissues upwards, there is no doubt in my mind that they do frequently increase the obstruction; indeed occasionally their removal is followed by immediate and permanent improvement in the hearing power. Their removal must, however, be usually considered only as a beginning of the treatment, or as getting rid of one great source of irritation to the mucous membrane of the pharynx.

Mode of removal.—First, by the bistoury and forceps, which is a very favourite method. A probe-pointed bistoury must always be used, and the sharp edge of the blade should only extend half way down from the point. The patient, having been placed facing a good light and with the mouth wide open, the surgeon seizes the tonsil with the forceps, draws it towards the median line and

removes it by cutting upwards or downwards as he may think best. For the left tonsil the operator should stand in front of his patient, for the right, behind; unless he happens to be ambi-dextrous.

There are some cases on record where the surgeon using this method, has wounded the internal carotid artery; but in nearly all these a sharp pointed knife had been used, which was of course highly injudicious. It is also possible that in some of these cases, the injured vessel was an abnormal branch of the artery.

Removal by the tonsil guillotine.—The two chief forms of this instrument are:—

FIG. 26.—The Spade Guillotine.

1. *The French or ring guillotine;* which consists of two rings, one sliding over the other so as to nip and cut through the tonsil by pressing it against the sharp edge of the cutting ring. This is the older form, and not nearly so practical as the spade guillotine, both on account of its being more complicated, and also because it takes up more room in the throat.

2. *The spade guillotine.*—This is by far the most useful instrument for removal of tonsils, and for ordinary

cases is to be preferred to the bistoury and forceps, as it is safer and easier to manage, besides having the advantage of enabling the tonsil to be removed more evenly; for when the knife is used the cut surface is necessarily somewhat concave, owing to the tonsil having been pulled forward by the forceps previous to its removal.

The spade guillotine consists of a long flat blade, like a spatula, with a large circular or oval opening at one end, and at the other a handle which is set at almost right angles to it. Sliding on this in suitable grooves, is a spade-like instrument with a sharp cutting edge. (See fig. 26). The spade being withdrawn from the opening, the instrument is introduced into the throat so that the tonsil passes through it. The surgeon then with his thumb pushes down the spade and the tonsil is thus cut off.

A fork is sometimes added to the instrument to hold the tonsil, but this, to my mind, is a useless complication and only gets in the way. The tonsil always comes away with the guillotine, so that practically there is no danger of its falling down the throat.

Considerable knack is required to do this operation skilfully, but when once the knack is acquired there is rarely any difficulty other than persuading the patient to keep the mouth open. Nor is this, as a rule, a difficult matter, for the spade guillotine is not a formidable looking instrument, and you can promise that there will be but little pain in the operation; indeed, very frequently there is none at all.

The surgeon should have by him two or three sizes of this guillotine; and it is important that the hole should be as large as the strength of the instrument will allow.

There are other appliances that are sometimes used,

such as the galvano-cautery, écraseur, special scissors, etc., but I do not recommend them in preference to the methods above described. Occasionally when the patient persistently objects to any cutting operation, strong caustic pastes are used to destroy the tonsil, but this mode is far more disagreeable and often unsatisfactory in its results.

After the operation there is rarely any trouble except occasionally some little inflammatory swelling a few days afterwards. Should hard food irritate the cut surfaces, then it must be taken in a fluid or soft form, but very frequently this is quite unnecessary.

Removal of tonsils must never be attempted in patients of a hæmorrhagic diathesis, nor should the operation be performed during acute inflammation or ulceration, especially if it is of a syphilitic nature.

The hæmorrhage following after the removal of tonsils is rarely of any moment, but should it be troublesome the application of perchloride of iron in the form of a *saturated* glycerine solution, will certainly stop it unless the patient is hæmorrhagic or the internal carotid artery has been injured. In the latter very remote contingency, ligature of the common carotid is necessary.

The removal of adenoid growths.—When these masses are pendulous they should be removed either by forceps, by forceps and scissors, by the curette, or by means of the finger nail. Meyer recommends a sort of crushing forceps and a ring knife passed through the nostrils, to be guided by the finger introduced behind the soft palate; Delstanche employs curved forceps; Roosa uses a curette; whilst Lœwenberg usually prefers the galvano-cautery. But I agree with Cresswell Baber, that scraping with the finger nail is by far the most satisfactory means for the removal of these

masses, whether pendulous or adherent. For this purpose the forefinger is introduced well up behind the soft palate, and the nail, which should be long and quite clean, is used to scrape the mucous membrane so as to remove the growths, or if too adherent to break them down. This is always an unpleasant operation, and sometimes very painful, therefore when general anæsthetics are not employed, the palate and fauces and naso-pharynx should be painted with a solution of cocaine (about five per cent.) two or three minutes beforehand. Care should be taken, however, that the solution does not run down into the larynx.

If the masses be adherent then, after breaking down, applications of a solution of chromic acid five per cent., or of tannin (glycerinum acidi tannici), or a strong solution of perchloride of iron should be employed from time to time, either by the surgeon himself, or by some competent person, care being taken that the brush is passed well up behind the soft palate. At the same time the patient should use, night and morning, astringent nasal injections; solutions of tannin half to one per cent. are very serviceable.

These adenoid growths should always be removed when they are abundant or interfering with a due supply of air to the Eustachian tubes. Frequently even when there is a fairly free passage of air through the nasal passages, examination with the finger will reveal a thick cushion of this tissue. But in a certain proportion of these cases where the masses are not large, the use of tannin nasal injections, together with applications of tannin or chromic acid, is all that is necessary to reduce the adenoid condition sufficiently for all practical purposes.

Free supply of air to the tympanum.—Thus far

we have been speaking of the first object of treatment, viz., the methods for reducing the catarrh; we now come to the second, how to bring a due supply of air to the tympanum?

This may be effected by one of the following plans.

Valsalva's method of inflation, (see page 37). This by itself is generally insufficient, but the knack being easily learnt, it is often a ready means of keeping the Eustachian tubes patent after they have been opened up by some other method of inflation. The patient must, however, be cautioned against repeating it too frequently, lest he render the membrane flaccid, which proves an awkward complication.

Politzer's bag (see page 38). The use of this is almost always advantageous, and should be repeated every now and then. I prefer to use it from once to three times a week, rarely oftener lest the tympanum become over inflated.

The catheter may be helpful when Politzer's bag alone fails to open the Eustachian tube, or when it is important that the Eustachian tube of one side only should be treated. Or again, when it is desirable to introduce special vapours or solutions into the tympanum.

Should inflations of ordinary air by these means fail, they may succeed if ether or chloroform vapour is used instead. Sometimes too, the inflation, previously impossible, becomes feasible after the production of coryza, by means of iodide of potassium as already mentioned.

Many aural surgeons make use of the Eustachian bougie when there is a difficulty in opening the tube. This is introduced through a catheter previously passed into the Eustachian tube, and then insinuated with a rotary movement gently forward right through the tube. It is important to be extremely gentle in passing

the bougie along for the first quarter of an inch after it has left the beak of the catheter (Guye); after which point it may be pushed forward more boldly.

All, or nearly all, English and American surgeons have given up the use of the bougie; some on account of the dangers that are apt to result therefrom, as exemplified by the late Mr. Hinton, others because they doubt the value of the operation. On the Continent, however, it still finds considerable favour, although the eminent authority, Prof. Politzer, and some other surgeons have discontinued its use. Prof. Politzer substitutes for it in certain cases a minute india-rubber bag introduced through the beak of the catheter and then inflated, somewhat after the manner of Barnes' uterine bag.*

There is one other method of bringing air into the tympanum, and that is by perforation of the membrana tympani itself. Sir Astley Cooper found that the hearing of a certain deaf patient was considerably improved by perforation of the membrana tympani, but that the improvement passed off in a day or two owing to the rapid closure of the aperture. Since then surgeons have from time to time performed this operation with similar results. Many plans for keeping the perforation open have been suggested and tried, but none have been really successful, although Professor Paquet (Lille) has described a method (page 4, "Diseases of the Ear," *Transactions International Congress*, London, 1881), where by removing a large portion of the membrane he had been enabled, in a few cases, to keep the perforation from closing for a considerable period, in one instance for two years. Again, Kessel recommends the removal

* The above is a summary of the opinions expressed at a discussion on the subject at the International Otological Congress, Bâle, 1884.

of the tendinous ring of the membrane to prevent its repair. Nevertheless, although this perforation of the membrane would be a very advantageous method of ventilating the tympanum were it possible to keep it patent, this being practically unattainable, the method is of no real value.

Restoration of the membrana tympani to its normal position.—The third object of treatment is the *restoration* of the membrana tympani to its normal position. The general methods used to accomplish this are the various modes of inflation just referred to; besides these, suction of the meatus is sometimes employed, either by means of the mouth and a tube fitting tightly into the meatus, or by using Siegle's pneumatic speculum.

The membrana tympani frequently becomes adherent to the promontory, in which case it is important to separate it, if possible. This may often be done by forcible inflation, by means of the catheter and Politzer's bag, especially after the exhibition of iodide of potassium internally.

Prognosis.—In early life, *i.e.*, before fourteen or fifteen years of age, the prognosis is usually most favourable, even in very severe cases. Sometimes the disease will yield to very simple remedies, such as the use of an astringent gargle and occasional Politzerisation. But when it occurs in later life the prognosis is less and less favourable; the tendency to increased thickening of the tympanic mucous membrane causes the deafness to progress steadily until the patient becomes very hard of hearing, although he never becomes stone deaf unless the internal ears are also affected.

There are few cases, however, that will not derive some benefit from persistent treatment, and it must be

borne in mind that wherever we have to deal with a bad case of deafness, any improvement of the hearing power is an immense gain to the patient and will be highly appreciated by him.

Adhesion producing anchylosis of the ossicles is a very unfavourable condition, as is also permanent occlusion of the Eustachian tube; or again, adhesions binding down the membrana tympani.

A somewhat rough guide may be obtained by observing the effect of inflation upon the hearing power, the prognosis being favourable in proportion to the improvement produced. Again, the amount of mobility in the membrane may be looked upon as another guide.

PROGRESSIVE TYMPANIC DEAFNESS, NON-PROLIFEROUS CATARRH, SCLEROSIS, FIBROSIS.—The above names have been given to a certain form, or possibly, many forms of middle ear deafness whose pathology is yet a matter of extreme doubt.

These cases are frequently complicated with a certain amount of true catarrh, but this is not at all a necessary accompaniment. Sometimes, too, they may result from paresis of the tympanic muscles, as suggested by Weber-Liel, and Woakes; while another section is probably due to localised adhesive inflammation, producing more or less anchylosis and immobility of the ossicles. But allowing for all these separate causes there yet remains a large residuum of cases whose pathology has not hitherto been explained.

The condition is more frequent in females than in males, is very apt to come on between twenty and thirty, especially in anæmic patients, and often appears to be the result of a strong hereditary tendency. In these cases especially, we find increased deafness at

Symptoms and diagnosis.—*Deafness*, variable in degree, is a never-failing symptom, although the loss of hearing power varies in different cases, from a scarcely appreciable degree, to total deafness. This variation does not depend upon the size of the perforation, but upon the amount of change in the tension and mobility of the membrana tympani and ossicles; the popular notion, therefore, that a perforation is fatal to the hearing power, is a complete fallacy.

Tinnitus is an occasional symptom.

Discharge of pus from the meatus, or at any rate from the tympanic cavity into the meatus, almost invariably occurs, although it is possible to have the disease without any discharge through the membrana tympani. In such cases the pus is either locked up in the tympanic cavity (a very serious condition) or else it finds an exit through the Eustachian tube.

The character of the pus differs according to the condition of the tympanic cavity and meatus.

1. *Healthy pus.*—In a typical case the discharge consists of a somewhat thin, laudable pus.

2. *Ropy.*—After recent acute inflammation the pus may be of a ropy nature, owing to the admixture of mucus.

3. *Thin or watery.*—During the healing stage, when the parts are becoming more healthy, the discharge is scanty and of a watery character. On the other hand, a thin, watery, but acrid and copious discharge, is found in neglected cases, especially in young children.

4. *Sanguineous.*—Blood is often found mixed with the discharge, and denotes the presence of some granulating surface or a soft polypus.

5. *Fœtid.*—The discharge in neglected cases is usually more or less fœtid. When excessive fœtor does occur

in regularly cleansed cases, and especially when the pus is of a brownish colour, it is an indication of diseased bone.

Perforation.—With the exception of those rare cases to which allusion has been already made, *i.e.*, when the pus is either locked up in the tympanic cavity, or when it only finds an outlet through the Eustachian tube, a perforation is always present in chronic suppurative inflammation or internal otorrhœa; and indeed, its presence or absence is one of the distinguishing marks between external and internal otorrhœa.

Diagnosis.—The existence of a perforation may be ascertained in several ways.

Occasionally fluids injected into the ear will pass right through the Eustachian tube and out of the nose or down the pharynx. This, of course, is an infallible sign of a perforation.

Again, on examining the ear with a speculum, we sometimes find a drop of pus filling up a perforation (though apparently lying on the surface of the membrana tympani), which drop is distinctly seen to pulsate. This appearance is almost a certain sign of the existence of a perforation.

These modes of diagnosis, however, depending as they do upon circumstances which may be called accidental, can only be utilised in few cases. The two most general means of ascertaining the presence of a perforation are either by *seeing* it, or by *hearing a peculiar whistling sound* which is produced by air escaping from the tympanic cavity, when it is inflated by any of the various methods.

Before a perforation can be seen it is usually necessary to cleanse the meatus; then with the aid of the speculum the opening can, in most cases, be easily

discovered. However, it may possibly be so small that it is not seen, or it may be invisible on account either of its valvular shape or because that portion of the membrane is outside the field of the speculum. In these cases Politzerisation or inflation by Valsalva's method should be performed while the membrane is under observation, then should a perforation be there, a little pus bursting through will reveal its position. Or again, the diagnostic tube may be used; then on Politzerisation a slight whistle will denote the existence of an opening.

Form of perforation.—The perforation may be of any size, from a minute pin-hole to that of complete, or almost complete, loss of the entire membrane.

The following are the chief varieties, (see fig. 27).

1. Pin-hole perforation.

2. The typical one, a round or oval hole of larger dimensions.

3. *Kidney-shaped perforation* (fig. 27, *c*).—If the perforation is still larger and confined, as it often is, to the lower segment of the membrane, it assumes a kidney shape, due to the long handle of the malleus (which is partly denuded of membrane) projecting into it.

4. *Healing perforation* (fig. 27, *d*).—When a membrane is healing across, the margin usually presents a zone of thin finely-injected membrane. This gradually encroaches on the hole until it is completely obliterated. In favourable cases this thin membrane gradually assumes the characters of the normal structure, but in others it always remains thinner than the surrounding tissue, and appears as a cup-shaped depression, which is caused by the external atmospheric pressure.

5. *Unhealthy perforation* (fig. 27, *e*).—Here the margin, instead of being thin as in the preceding case, is

much thickened, very red, and may be broken up into granulations, these granulations sometimes giving rise to polypi. This condition indicates a low type of inflammation of the tympanic mucous membrane.

6. *A dry free perforation.*—Sometimes we find a perforation which has healed round the margin after the suppurative disease of the tympanum has disappeared. This, as a rule, is a very satisfactory result.

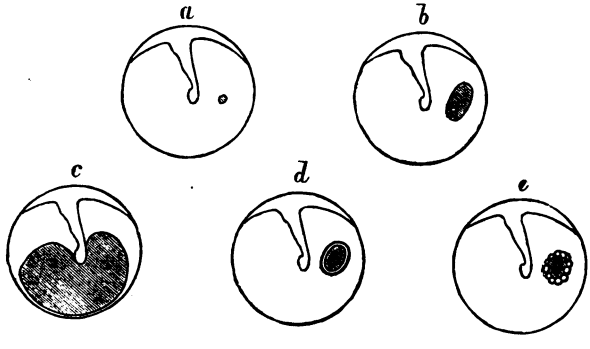

FIG. 27.—Diagrammatic sketches of various forms of perforation of the membrana tympani. *a.* The pin-hole. *b.* The typical oval. *c.* The kidney-shaped. *d.* The healing. *e.* The unhealthy, fringed with granulations.

7. *The dry adherent perforation.*—Again, the margin of the perforation in healing may become adherent to the inner wall of the tympanum. This condition is usually far more unsatisfactory with respect to the hearing power, but as regards the disease itself it is by no means an unfavourable termination.

8. *Perforation in the membrana flaccida.*—A perforation in this position is most unsatisfactory as regards both the healing of the disease, and also the restoration of the hearing power. One reason for this is the great difficulty that there is in the application of remedies

through such perforations, and as disease in this position is very liable to interfere with the ossicles and their attachments, considerable loss of hearing power usually accompanies it. Lastly, it is in a bad position for drainage.

I would here warn the reader of the possibility of mistaking a large foramen Rivini in the membrana flaccida, which is a normal condition in some few individuals, for a dry perforation left by disease. These foramina, when they are examined, have every appearance of being the work of nature and not of disease. This, together with the existence of a symmetrical foramen in the membrane of the other ear, should be sufficient to prevent the mistake.

The relation of perforation to the loss of hearing power.—As already stated, one of the many widespread fallacies in connection with ear-disease, is the supposition that a perforation of the membrana tympani necessarily entails extreme deafness. The truth is that a perforation, though usually producing a certain amount of diminution of hearing power, may have some compensating advantages, such as equalising the atmospheric pressure on each side of the membrane, and is far less injurious than an adhesion to the inner wall of the tympanic cavity. This will be readily understood if we bear in mind what is the true function of the membrane and ossicles; which is, we repeat, that of picking up the sound waves from the gaseous (atmospheric) medium and conducting them to the fluid contained in the labyrinth. For this purpose due tension of the membrane is necessary, and also free mobility of the ossicles; and so long as these two are not interfered with, no serious amount of deafness will occur.

When, however, a very large proportion of the

membrane is lost, the essential part of the conducting apparatus—the membrane and ossicles—tends to fall outwards, and so loses its due tension. In these cases a considerable diminution of hearing will probably result, but this may be partially restored by means of an artificial tympanum to be presently described.

Treatment.—The indications for treatment in these cases of chronic suppurative catarrh, are:—

1. To subdue the suppurative disease and to render the surfaces healthy.

2. To heal the perforation in the membrana tympani. This is almost entirely dependent upon the success of the preceding, because a perforation rapidly heals—either across or at its margin—when the discharge has ceased.

3. To restore the hearing power.

To subdue the suppuration.—In a simple case, thorough cleansing by means of warm injections is frequently all that is necessary to induce a healthy reaction, and thus allow the *vis medicatrix naturæ* to effect resolution. But to render the cleansing process more perfect it is well to add some antiseptic, boracic acid, permanganate of potash, carbolic acid or the like; and also some one of those agents which stimulate the healing process, as acetate of lead, acetate of zinc, sulphate of zinc or alcohol.

In the majority of cases, however, something more than mere cleansing is required, and then one of the following modes of treatment should be adopted.

a. Instillations.

b. The dry treatment.

c. The absorbent treatment.

a. Instillations.—After the ear has been cleansed with some antiseptic injection and thoroughly drained, it

should be completely or almost completely filled with the instillation which must be slightly warm, the patient lying so that the affected ear is uppermost, and remaining in that position for at least 20 minutes after its introduction.

Further, in those cases where the perforation is small, the patient should perform Valsalva's inflation, by which means the fluid will be sucked into the tympanic cavity during the reaction.

Liquor plumbi subacet., either as it is or somewhat diluted, is a very useful although old-fashioned form of instillation. It has, however, the disadvantage of covering the surface with adherent scales which sometimes interfere with the due cleansing.

Solutions of nitrate of silver (from 10 to 20 grains to the ounce) are used by some with great advantage, but as with these there is some risk of inducing acute inflammation, I prefer applying such solutions by means of a mop and not as instillations.

Alcohol.—This forms by far the most satisfactory instillation both on account of its stimulating and antiseptic action, and on account of its penetrating power which enables it to make its way into all the irregularities of the bony cavity; besides which, it shrivels up and thus destroys soft granulations with marvellous success. Rectified spirit should be used, at first diluted 1 in 4, and rapidly increased in strength if it produces no continuous pain, momentary stinging is of no consequence.

It is a curious fact, that often, when the first instillation of the solution produces pain, if this is allowed to drain out and a second quantity of the same is poured into the ear, no pain whatever will result therefrom. I usually add to the alcoholic solution, powdered boracic acid to supersaturation, so as to

obtain the beneficial effect of the boracic acid as well as of the alcohol.

This instillation, combined with previous syringing with some antiseptic fluid, repeated three or four times a day, forms my usual mode of treatment in the majority of cases of chronic internal otorrhœa; but I would here caution the unpractised hand against the use of alcohol in cases of caries and necrosis, where there is inflammation of the bone, or indeed any tendency to *acute* inflammation in the tympanum.

Many other solutions might be mentioned for the purpose, but the above are those from which I have obtained the most satisfactory results.

b. Dry treatment.—An old quack was in the habit of rapidly curing chronic otorrhœa by pouring in a paste of plaster of Paris, which on setting formed a hard plug. This, although it did undoubtedly heal a large number of cases, was of course an exceedingly dangerous mode of treatment, on account of the difficulty of removing the plaster of Paris whenever it failed in immediately arresting the disease. But if, instead of this, we use other powdered substances that are not liable to cake, and so can easily be removed, we may derive much benefit from them. In fact, in a fair proportion of cases, the dry treatment is by far the best, especially in those where the discharge is slight, the perforation considerable, and where granulations are not present, or at any rate, not abundant.

Numerous powders have been tried for this purpose, and among others, powdered French chalk used to be strongly recommended; but all have now given way before the superior claims of boracic acid.

Mode of application.—After the meatus has been thoroughly cleansed by means of syringing, or by

absorbent cotton-wool, or both, the ear must be filled with finely-powdered boracic acid, which should have been passed through a silk sieve to remove any small crystals that might become a mechanical source of irritation.

The ear may be filled either by blowing the powder into it through a quill,* or by using the speculum as a funnel for which indeed it is admirably adapted. In the latter case, the powder may be gently rammed down by means of any flat headed instrument. Finally, a small piece of cotton-wool should be inserted into the mouth of the meatus for the purpose of keeping the powder in its place. This process should be repeated from once a day to once in three or four days, according to circumstances; and as the discharge diminishes it may be left in as long as a week or even a fortnight. The cotton-wool should be removed by the patient every day so as to ascertain whether the discharge has soaked through, in which case the whole must be syringed out and the process repeated.

Excellent results may be obtained by this method, especially when dilute alcohol is used for the cleansing injection, the healing process sometimes being extremely rapid; thus, I have in my notes, a case where a single application was sufficient to conquer a discharge of nine years' standing.

c. The cotton-wool or absorbent treatment.—This may be regarded as another form of dry treatment. It consists of applying cotton-wool (absorbent cotton-wool), by which means the discharge is soaked up as rapidly as it is formed, while the diseased surfaces are

* For this purpose the quill should be fitted to a piece of india-rubber tubing ten inches in length, mounted at the other end with a mouth-piece of glass-tubing.

protected both from the action of the cold and the access of fresh septic germs.

Mode of application.—After cleansing the meatus, a long wick-shaped piece of cotton-wool is inserted by means of a pair of forceps, (see fig. 30), then gently pushed down to the tympanum and there allowed to remain. This should be changed once or twice during the day, according to circumstances, the meatus being cleansed each time if necessary.

Instead of using the simple cotton wick, it may be saturated with some antiseptic or other healing solution. Or again, the cotton-wool may be prepared with some of these substances in the dried state; thus the ordinary antiseptic boracic acid wool may be used, and indeed I prefer this to all others when using the absorbent mode of treatment.

This method is most advantageous in those cases where there is only a slight discharge, and where other modes of treatment are not readily borne; as for instance, where the ear will not bear much syringing.

Clinical experience alone will enable the practitioner to decide as to which of these foregoing methods should be used in each individual case, but the following general rules may assist him in his decision.

When the discharge is profuse, the use of repeated injections is naturally indicated; if fœtid, the addition of carbolic acid or other strong disinfectant, becomes necessary. Any tendency to *acute* inflammation, as already stated, contra-indicates the use of alcohol, though not of boracic acid powder.

When a zinc and carbolic acid injection fails to arrest the discharge, although it has considerably lessened it, then the alcoholic, the dry, or the absorbent method, will usually succeed. Should there, however, be any

sign of bone mischief, it may be unwise to heal the discharge too rapidly; in such cases, therefore, injections of carbolic acid and zinc, or solutions of boracic acid are to be preferred.

Mode of syringing the ear.—Generally speaking, a patient cannot syringe his own ears, although when only very gentle syringing is necessary he may do so; in which case he should make use of an India-rubber ball syringe. When the friends of the patient are entrusted with this office, it is best to order an ordinary straight

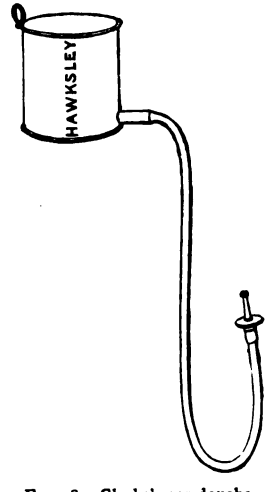

FIG. 28.—Clarke's ear douche.

glass syringe, as this is not so liable to be used too forcibly.

In rare cases where thorough syringing is necessary, a good brass syringe with fine nozzle (as recommended p. 60) may be allowed.

Where the syringing produces pain or severe giddi-

ness, and yet thorough cleansing is necessary, Clarke's douche or some modification of the same should be used. (See fig. 28).

Accessory Treatment :—

Naso-pharyngeal and Eustachian.

Counter-irritation.

General (general health).

Naso-pharyngeal and Eustachian.—As by ar the larger number of cases of chronic suppurative catarrh have their origin in naso-pharyngeal catarrh, it behoves the surgeon to treat these parts as carefully as the disease itself. For it has often happened that a discharge which has obstinately refused to yield to direct treatment, has soon been overcome when the naso-pharynx and the Eustachian tube have received proper attention.

Counter-irritation by means of liniments, mustard, iodine, and best of all, blisters, behind the ear, is occasionally a very useful adjunct to the direct modes of treatment, especially where there is any tendency to acute inflammation or active congestion of the mucous membrane of the tympanum (as indicated by the pulsation of the pus, see page 113), or again where any disease of the bone exists.

General health.—Due attention to general health should never be forgotten in treating the local condition.

In infants and strumous patients, constitutional treatment is almost always required. The necessity for proper diet, good air, etc., must be insisted upon; and tonics, such as phosphates of iron, quinine in small doses, cod-liver oil and the like are invaluable in many cases, although of course each individual one must be treated according to its own peculiar requirements.

The importance of this cannot be too strongly insisted

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upon, as there is great tendency to lose sight of the fact that the ear is only part of the whole, and must therefore be influenced by the health of the rest of the body.

The artificial membrana tympani.—In 1841, Dr. Yearsley discovered a very valuable means of improving the hearing in certain cases of perforation of the membrana tympani. He was led to this discovery by a patient who showed him how he was able to restore his hearing in one ear by introducing a quill of paper

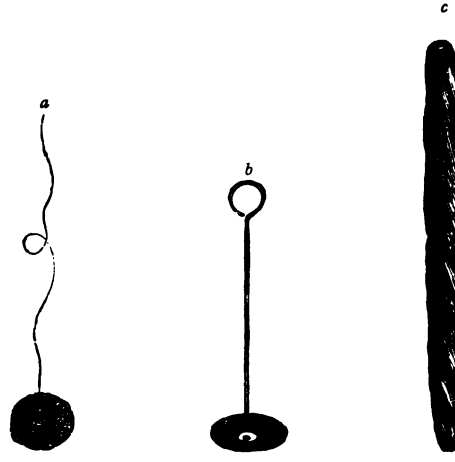

FIG. 29.—Artificial tympana.
a. Yearsley's (cotton wool). *b*. Toynbee's. *c*. The wick (cotton wool).

right down to the injured membrane. Yearsley found this was correct, and that it answered in many other similar cases; he, however, substituted cotton-wool for the paper, and this, in some form or other, is still the favourite material used. Toynbee soon after obtained the same results by means of a disc of sheet india-rubber, with a wire or piece of thread attached to the centre of it. (See fig. 29).

There have been many modifications of the so-called artificial tympanum since those of Yearsley and Toynbee, and the forms now most generally in use are:—

1. Yearsley's cotton-wool pellet.
2. The wick.
3. Toynbee's.
4. Various discs of paper, linen, etc.

Yearsley's is a moistened pellet of cotton-wool, to which a piece of thread is generally attached.

The wick is merely a modification in form of Yearsley's, and consists of a wick-shaped piece of cotton-wool moistened and pushed down to the membrane. This is by far the most useful both on account of its easy application and removal, and also because it is less liable to become displaced, being kept in position by the larger surface it presents for support against the walls of the meatus.

FIG. 30.—Forceps for introducing Yearsley's artificial tympanum and the wick.

With Toynbee's artificial tympanum, the wire handle is used to introduce and withdraw the disc which must be pushed right down to the drum-head. When a thread is substituted for the wire, forceps, or a fine quill (through which the thread is drawn) should be employed for the introduction of the disc.

Various discs made of paper, linen, etc., have been and are used for this purpose, but there is always considerable difficulty in their application and removal.

Mode of action.—It is just possible that the artificial tympana act in some small degree as true substitutes for the membrane; that is to say, that they do help to

pick up the sound waves, but their value in this respect can only be infinitesimal. No doubt the improvement of hearing power is almost entirely due to the pressure exerted on the ossicles and remnant of the membrana tympani; for in this way they are restored to their right position, and that due tension which is necessary for the reception of sound-waves, is given to the whole.

The artificial tympanum is therefore only to be regarded as a substitute for the membrana tympani in so far as the membrane acts as a ligament holding the ossicles *in situ*, and not in respect to its chief function.

Advantages.—1. The increase of hearing power, which is its chief advantage.

2. Its healing action on account of the absorbent power cotton-wool possesses; as will be understood by referring back to page 120.

3. By forming a protection to the otherwise exposed and delicate tympanic mucous membrane.

Precautions to be observed in its application.—As the application of an artificial tympanum requires great nicety of adjustment and as it is absolutely necessary that the patient should learn to apply it for himself, the surgeon must take great pains to teach him to do so.

Some patients manage in one or two lessons to apply this artificial aid more perfectly than the surgeon himself, while others will require to be shown a great many times. The ear will not always bear the presence of this foreign body without considerable irritation, therefore the patient should be cautioned not to wear the wick more than a few hours a day at first, gradually increasing the time until it is worn all day long. But it is never advisable to leave it unchanged more than 24 hours, and the best plan, perhaps, is to put it in every morning and to take it out at night.

Occasionally the patient will experience extra difficulty in adjusting the wick so as to obtain the due increase of hearing, and is tempted to continue his efforts until irritation is set up. Against this he should be carefully warned. If inflammation should result, the use of the plug must be deferred until it has quite subsided.

It is necessary for the proper effect of the wick to be gained that it should be slightly moist, otherwise its advantages are greatly minimised. To prevent drying it is well to add a little glycerine to the water with which it is moistened.

Cases suitable for its application.—It is most useful where there is a large perforation, particularly if this involves the lower portion of the membrane, in which case it seems that the larger the perforation the more chance of the artificial aid being of service. It is especially adapted for use when the perforation is kidney-shaped. (See fig. 27).

In cases where the patient notices that his hearing is always considerably improved immediately after syringing, the surgeon may be almost certain to obtain good results from the use of the wick; and indeed in no case of considerable perforation should he omit to test its value, except where profuse discharge or any tendency to acute inflammation contra-indicate its use. Occasionally, even when its careful application has failed to prove beneficial at the first trial, yet, if after the lapse of a few months, it is tried again, the second attempt may prove successful.

As already stated, this little contrivance will frequently act as if by magic, and every aural surgeon has come across cases in which the patient, long supposed to be past all aid, has been by its means restored to intercourse with the world.

The most perfect success that I have ever witnessed in connection with this was in the case of a lady who had been wearing an artificial tympanum on each side for thirteen years. When removed, the hearing distance was only 1 per cent. by my watch, but when the wicks were inserted this was increased to between 60 to 70 per cent. In other words, without these aids she could scarcely hear loud conversation at the shortest distance, whereas by their use her hearing was practically normal; and curiously enough in her case there was scarcely any part of the membrana tympani remaining on either side.

As a rule the beneficial effect increases as time goes on, and in those very few instances that have come under my notice where the hearing power has decreased, this has been due to the healing of the membrana tympani in such a manner as to interfere with its proper vibration.

COMPLICATIONS OF CHRONIC SUPPURATIVE CATARRH:—

Granulations.
Polypi.
Exostosis.
Loss of ossicles.
Ostitis, caries and necrosis.
Facial paralysis.

Granulations and Polypi. *Pathology.*—I propose to consider these granulations and polypi together because of their pathological relationship. They are, in nearly every case, the result of chronic suppurative inflammation alone, or of this condition combined with periostitis.

In the former case the tendency is to develop from granulation tissue to myxoma, through gradual stages to soft fibroma, until the dense fibroma is reached, and this again may go on to ossification.

If there is not much increase in substance, the condition never passes beyond that of granulations or a granulating surface, but tends finally to produce a layer of fibrous tissue which may fill up a portion of the tympanic cavity. This will leave a cushion of newly formed fibrous tissue adherent to the inner wall of the tympanum, and in some cases adherent on the outer side to the remnants of the membrana tympani. I may here remark that this is a very unfavourable condition as regards the hearing power.

If, on the other hand, increase of substance occurs and the granulation enlarges, a polypoid tumour or polypus is the result. This may grow larger and larger until it fills up the meatus, and may even protrude from the external opening. These polypi pass through the same histological stages (from myxoma to fibroma) as already described. They are covered by a layer of mucous membrane with epithelium corresponding to that of the surface from which they have grown. Thus we may have them covered with columnar ciliated epithelium, or with the stratified squamous variety. They are well supplied with blood-vessels, which sometimes increase to such an extent as to bring the tumour under the class of angioma. Occasionally clefts and cavities lined with epithelium are found in polypi, these cavities being due to the union of two epithelial surfaces leaving a space between.

Soft, rapidly-growing granulations or polypi are almost always to be met with in the course of periostitis, caries or necrosis. They correspond exactly to the fungating granulations found around diseased bone in other parts of the body, and rarely pass beyond the stage of myxoma unless the ostitis becomes very chronic.

From the foregoing pathological history of polypi,

three forms of this tumour will have been accounted for; namely: —

1. Myxoma.

2. Fibroma (which again may be subdivided into the loose and dense variety).

3. Angioma.

To these must be added epithelioma, a very rare form of polypus.

Early authorities were in the habit of dividing polypi into false and true, according to whether they were soft or firm; the false therefore corresponding to the soft myxomatous polypi, and the true to the firmer fibrous ones.

Diagnosis.—Unless there has been pre-existing otorrhœa, the occurrence of polypi and granulations is almost impossible; on the other hand, whenever in the course of otorrhœa blood is found mingling with the pus, their presence may be confidently predicted.

To discover granulations and the smaller polypi, the meatus must be carefully cleansed, either, by syringing or drying out by means of cotton-wool mops,* then the speculum and a good light will reveal their presence. It is often impossible to diagnose between a small polypus and a granulating surface by these means alone, but the use of a probe with flattened end will soon decide the point, for if this can lift up or pass round the mass, it must of course be a polypus. Granulations and the smaller polypi are almost always of a bright red colour, but they assume a paler tint when developed into fibrous tissue.

* These are made by twisting a little absorbent cotton-wool round the end of a cotton-holder. The best form of holder is an ordinary probe, the rounded end of which has been filed flat; this flat end readily twists up the wool and yet allows the mop to be easily slipped off after use.

Polypi may also be mistaken for exostoses, but the hardness of the latter when felt with a probe, makes it an easy matter to distinguish between them.

Again, we sometimes, although very rarely, have to do with a sebaceous tumour projecting from the wall of the meatus which bears a resemblance to a polypus, but in such cases there is rarely any discharge, and by its appearance as well as by application of the probe, a correct diagnosis is easily made.

When the polypus comes near to, or projects from the opening of the meatus, it may be mistaken for a furunculus, especially as the surface of these polypi is often pale like the skin. A probe passed round the tumour will, however, at once resolve the difficulty.

A polypoid outgrowth of epithelioma may sometimes be taken for an ordinary polypus. Although with the former we also get purulent discharge, very often containing blood, and it is a distinct polypoid growth; yet these may be distinguished by the age—the patient being usually past middle life, by the cachexia, by the rapid growth of the tumour, especially after partial removal, by its brittle nature, and by the intense pain produced by the tumour itself. These are usually sufficient data to enable us to form a correct diagnosis, but the matter may be made certain by the microscopical examination of a portion.

There is another very rare form of disease which may be mistaken for an ordinary polypus, namely, a true angiomatous tumour of the surrounding tissues, a portion of which may project into the meatus in the form of a polypus. This may be recognised by the tendency to hæmorrhage which is excessive on any attempt at removal. This tumour is also generally accompanied by very great pain.

It is important to distinguish between the ordinary slow-growing polypi and those of an inflammatory origin (for signs of ostitis, caries and necrosis, see page 139), on account of the difference in the treatment, as will presently be seen.

Treatment of granulations.—When granulations are abundant, it may be advantageous to break them up with forceps before proceeding to other means; but as a rule this is not necessary.

By caustics, etc.—Various caustics have been used for the purpose of destroying granulations; as nitrate of silver, chloro-acetic acid, iodoform, chromic acid, and perchloride of iron.

Nitrate of silver.—This should be used either in the form of a strong solution (30 grs. to 1 oz.) applied by means of a cotton mop at the end of a probe or cotton holder, or in the solid state. For the latter purpose the following will be found a very practical method. Heat the rounded head of a probe to redness in the flame of a spirit lamp, and plunge it into some powdered nitrate of silver. On withdrawal, a bead of nitrate of silver will be found fused on the point, and this may be readily applied through a speculum to the granulations.

This caustic answers well for granulation surfaces and small granulations, but its action does not penetrate deep enough to make it of value when they are more abundant.

Chloro-acetic acid and iodoform are strongly recommended by some aural surgeons, but I prefer the following.

Chromic acid.—I have always found this the best form of caustic whenever penetrating power is required. Its effect passes deeply into the tissues, so as readily to shrivel up granulations and even small polypi. It should be used in the following manner.

The tip of a probe or cotton-holder should be covered with a little tightly twisted cotton-wool and slightly moistened. A few crystals of chromic acid must then be picked up at the tip and applied through a speculum to the diseased tissue.

The galvano-cautery.—This is a very useful means of destroying large granulations, but requires considerable care.

By astringents, stimulants, and dehydrates.—Powdered burnt alum applied to the cleansed surfaces makes an excellent astringent, but it has the disadvantage of caking and thus forming a mass that may be difficult to remove. Powdered acetate of lead was at one time much recommended, as was also tannic acid, but these have now all given way to alcohol, which undoubtedly yields the best results, except when the granulations are accompanied by inflammation. The alcohol should be used as already described. Perchloride of iron is a very useful astringent, especially when there is a marked tendency to hæmorrhage. It may be used as an adjunct to alcoholic instillations (Tr. Ferri Perchlor. ʒ j, to Sp. Vini Rect. ʒ ij); or applied by means of a small cotton-wool mop, either in the form of the anhydrous powder, or Sir James Simpson's saturated solution of the salt in glycerine (See Appendix).

Granulations with inflammation are best treated by counter-irritation (*i.e.*, blisters behind the ear), together with the application of nitrate of silver.

In all cases the otorrhœa must be treated as well as the granulations.

Treatment of polypi.—Ordinary polypi should be treated first by removal, and secondly by destruction of the stump or unhealthy surface from which they may re-form. The latter is most important, as without it a polypus is sure to grow again.

Removal.—Simple syringing will occasionally remove a polypus, but this is rare, and cannot be depended upon.

Torsion by means of forceps or snare.—This consists of seizing the polypus as low down as possible, either by some kind of forceps, or by means of a wire snare, and then twisting it round and round until it is torn off.

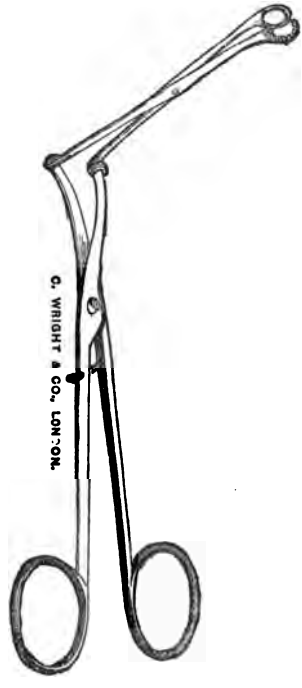

FIG. 31.—Toynbee's or Hinton's polypus forceps.

Numerous forceps have been devised for this purpose; I prefer Toynbee's or Hinton's ring forceps (see fig. 31).

Strangulation.—Instead of twisting the polypus suffici-

ently to tear it off, it may simply be twisted enough to produce strangulation, and thereby death of the tumour, which will then come off in a few days as a slough. This treatment is most appropriate when the pedicle is very strong, and the surgeon fears that the parts surrounding it may be injured by actual torsion.

By the snare.—(See fig. 32). The snare may be used

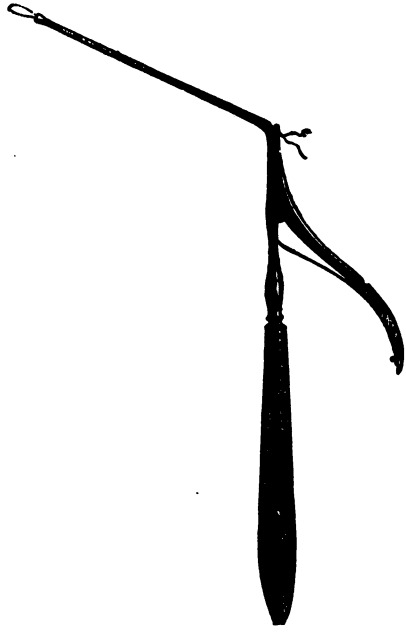

FIG. 32.—Polypus snare.

to cut through the pedicle instead of torsion, and, although this does not remove the tumour so completely, it is a favourite method with many surgeons, and I myself prefer it in those few cases where it is advisable to remove inflammatory polypi.

By the cutting ring.—This instrument is sometimes used. It consists of a long handle terminating at the end by a small ring, the inner edge of which is sharpened. The ring is passed over the polypus, and, on withdrawal, the sharp edge cuts through the pedicle.

By breaking up.—Frequently the polypus is so soft that removal *en masse* is impossible. It must then be broken up by means of forceps.

By destroying vitality.—Occasionally a firm polypus with a broad base presents difficulties in removal by any of the above means; its vitality may then be destroyed in the following manner. Chromic acid or some other penetrating caustic should be inserted right into the centre of the tumour, which will then die and come away in a few days in the form of a slough.

Of all the above methods, that by torsion or by the snare will be generally found the most practical.

The surgeon will be much assisted in the removal of these growths, by previously placing the patient under the influence of an anæsthetic. Although this is by no means a necessity, especially when the polypus is large and firm, yet whenever it is small, friable, deep-seated, or multiple, the advantages of having the patient perfectly still are very great. For first, the least flinching on the part of the patient puts the meatus in darkness or out of view; and second, unless there is complete stillness it is often extremely difficult to get a good hold of the polypus at the first attempt, and, unless this is done, the hæmorrhage from the injured tissue completely obstructs the view.

In my hands, cocaine as a local anæsthetic in these cases has not proved to be of real service, probably because the solution of cocaine is not readily absorbed by the cutaneous surface of the meatus, and so does not

produce anæsthesia of this very sensitive part; and also because it does not penetrate sufficiently into the substance of the polypus itself.

Destruction of stump.—After the polypus has been removed, it is necessary to destroy the stump or surface from which it has grown. This is best done by the use of caustics or galvano-cautery, together with the alcoholic treatment.

The bleeding caused by the removal of the polypus usually prevents the caustic being satisfactorily applied immediately after the operation; it is therefore better to wait one or two days before doing so. But the alcoholic instillations should be commenced at once, and continued as long as there is any purulent discharge. As already stated, this after-treatment is all-important.

Exostosis.—On referring to page 80 it will be seen that a kind of multiform exostosis occasionally results as a complication of chronic otorrhœa. This is produced in some cases by the ossification of small polypi, in others by an outgrowth of bone from chronic periostitis.

Loss of ossicles.—In cases of great destructive suppurative disease of the tympanum, one or more of the ossicles may become detached and lost. This usually takes place through the loosening of their attachments and destruction of the blood supply; hence necrosis *en masse* results.

The incus is the bone most frequently lost, as might be expected on account of its less strong attachments, and more restricted blood supply.

The malleus is not often lost, because it is attached firmly to the membrana tympani, and from this it receives an ample blood supply. Therefore so long as a remnant of the upper part of the membrane remains,

this ossicle need not be lost; and as a matter of fact, we often find that the handle of the malleus is a prominent object in those cases where scarcely any of the membrana tympani is left.

The stapes rarely comes away, but if this should happen, the function of the internal ear is, of course, destroyed, as the oval plate forms part of the wall of the vestibule, and therefore its loss allows the escape of the fluid contained in the labyrinth.

The loss of the whole of the membrane and the two first ossicles need not involve anything like complete deafness, provided that the stapes is *in situ*, that the stapedius is attached, and that there are no adhesions causing anchylosis or fixation of the stapes.

In a typical case of this kind, which came under my notice at the Royal Ear Hospital, the patient, a lawyer's clerk, had sufficient hearing with the affected ear, (which, however, was the better of the two) to carry on his ordinary duties, and on measuring, I found his watch-hearing power to be one-fourth of the normal.

Periostitis, ostitis, caries and necrosis.—Some amount of periostitis and ostitis almost always accompanies acute inflammation of the tympanum. This is much more marked when the osseous portion of the meatus is involved, because of its intimate connection with the periosteum and skin (see page 8); in such cases inflammatory polypi are very frequent. These must be treated in the same way as other cases of acute inflammation of the tympanum and meatus; and blisters, kept open if possible, will always be found of great service when periostitis exists.

Chronic inflammation of the periosteum and bone is a frequent complication of chronic otorrhœa, and is specially liable to occur in patients of a strumous diathesis.

This renders the condition much more difficult to treat, and more tedious in its course, while the prognosis becomes graver on account of the increased danger to the meninges and brain. When this condition passes on to caries or necrosis, the progress of the case becomes much slower, and the prognosis still more unfavourable.

Diagnosis.—When periostitis is unaccompanied by caries or necrosis, the diagnosis may be very difficult; the presence of granulations, and the obstinacy in healing being the signs mainly to be depended upon. But the task is easier when caries or necrosis exist. The discharge is then grey or brown, fœtid (even when the ear is kept well syringed) and slightly tinged with blood, and it occasionally contains small gritty particles of dead bone. The granulations are more abundant, and indeed will frequently surround the carious spot or necrosed portion, and any uncertainty in the diagnosis will be resolved if, on inserting a probe, bare bone is felt. So that whenever a mass of granulations is seen, search should be made by means of a probe for a carious spot. I need scarcely say that the probe should be used with caution whenever its point is out of view. Again the speculum may reveal the necrosis itself.

The most frequent portion to necrose is some part of the vaginal process which forms the wall of the bony meatus, but any part of the petrous or mastoid bone may be so affected, and very large pieces have been known to come away through the enlarged meatus. Sometimes the cranium itself may be perforated by this means, so that the dura-mater is laid bare. In all these cases there is great danger of meningitis and pyæmic infection.

Treatment.—In this disease the use of alcohol, chromic

acid, and other active irritants is contra-indicated. Rapid healing by means of boracic acid powder is unwise in many cases, for occasionally if the surfaces are healed and the discharge stopped rapidly, disease of some neighbouring portion of bone will break out. Therefore the slower modes of healing are to be preferred.

Frequent injections of carbolic acid and zinc are very suitable, and, when the ear will bear it, I often make use of dilute nitric acid ($\frac{1}{2}$ per cent. solution, to which some carbolic acid has been added, see Appendix) with marked benefit. The nitric acid partially dissolves the carious particles, and thus gets rid of them more easily.

Sometimes a carious cavity in some part of the tympanum, especially at the top, is found to be filled with a caseous material. This requires to be very carefully removed by syringing, and the cavity afterwards mopped out with a solution of nitrate of silver. Unless this is done, there is little chance of healing the part, and I am quite in accord with Dr. Barr (Glasgow) who regards these deposits as a possible source of tubercular infection.

Besides these various means of cleansing, local applications of some caustic, of which nitrate of silver is the best, are necessary. When dealing with carious cavities or granulation surfaces, I like to apply a strong solution of nitrate of silver by means of a cotton mop at the end of a probe, which must, however, occasionally be bent in order to be at the proper angle for introduction. But for granulations and inflamed polypi which frequently accompany this condition, the solid nitrate of silver fused at the end of a probe (see page 132) is preferable. This should be applied freely to the diseased surfaces, and must be repeated from time to time. If the polypi become large enough to interfere with the due

exit of pus, they should be removed by means of a snare. Counter-irritation, especially by blisters kept open, will occasionally prove very useful.

When necrosis takes place, the necrosed portion should be removed by means of forceps, assisted sometimes by syringing, as soon as the dead bone is sufficiently loose to come away readily. But from the important relations of the auditory apparatus, it is obvious that in this position the sequestrum cannot be removed so early as it might be in other parts of the body, so that the course of necrosis here is extremely tedious.

Again, the size and shape of the sequestrum may be such as to render its removal extremely difficult, even when it has quite separated. In these cases dilute nitric acid injections, as already recommended, will sometimes prove of much service by decalcifying the sequestrum, and thus softening the prominent spiculæ which are apt to interfere with extraction.

General health.—As disease of the bone usually occurs in debilitated patients, and is very tedious in its course, careful constitutional treatment is always necessary. The diet should be of the most generous kind, aided by alcoholic stimulants, moderate in quantity and taken with the food; and sea-side residence, or failing that at least good country air, is almost indispensable. When advising a residence at the sea-side, the patient should, however, be warned against bathing in the sea, lest the cold sea-water should get into the ear and set up acute inflammation which might prove fatal. Tonics, such as the mixed phosphates, phosphates of iron, quinine, strychnine, etc., together with cod-liver oil, are also, as a rule, necessary.

Prognosis.—This is very much graver than when the otorrhœa is unaccompanied by disease of the bone; but

still the prognosis is not so serious as at first sight it would appear to be; for Nature with her customary foresight, gradually forms a bulwark around the diseased part with organised lymph, thus cutting it off from the deeper and important tissues. Indeed cases have been known where almost the whole of the petrous bone has come away in the form of a sequestrum, and yet the patients have made a good recovery as far as the disease itself was concerned.

The dangers to be apprehended are acute inflammation rapidly extending to the cranial cavity, meningitis, pyæmia and abscess of the brain, which will be presently considered.

Facial paralysis.—Facial paralysis, or in other words, paralysis of the portia dura of the 7th pair, occasionally takes place during the course of suppurative disease of the ear.

The liability to implication of this nerve will be readily understood when its relation to the tympanum is taken into account. It must be borne in mind that the aquæductus Fallopii, containing the nerve, is first an inner and then a posterior relation to the tympanum. So that inflammation may readily extend from the tympanum to this tube, and the inflammatory exudation pressing upon the nerve will then produce the very characteristic facial paralysis. If the pressure extends as far as the origin of the great petrosal nerve, paralysis of the uvula will also be noticed; and when the disease is so extensive as to destroy the nerve itself, permanent facial paralysis will result therefrom, and no treatment will be of any avail.

Fortunately, however, the mischief is usually but partial, and the nerve recovers its function as the parts become healthy. Repeated blistering behind the ear

will frequently relieve the pressure on the nerve, and and thus aid in restoring its function. Again, after all the inflammatory symptoms have passed away, galvanism (faradisation) will sometimes prove beneficial.

MASTOIDITIS, or inflammation of the mastoid process may be considered as a complication of suppurative inflammation of the tympanum, and can be divided into *superficial* and *deep*, according to the seat of the inflammation.

Superficial. *Pathology.*—Occasionally during the course of inflammation (more especially suppurative inflammation) of the deeper portion of the meatus, the disease extends through the gap left in the roof of the bony meatus by the incompleteness of the vaginal process in this position (see page 7), from thence it passes along the fissure between the vaginal process and the mastoid bone, and thus, getting under the periosteum, makes its appearance on the mastoid process itself. This, in my opinion, is the most common course and form of mastoiditis, especially in its acute form. Occasionally the inflammation spreads upwards and forwards to the temporal fossa, producing swelling and deep-seated fluctuation in this position.

Diagnosis.—The signs of acute superficial mastoiditis are exceedingly characteristic. A glance at the back of the patient's head shows that the auricle on the affected side stands out more prominently than that on the other. There is considerable redness and swelling over the mastoid process which pits on pressure, and is generally very tender. If pus has been already formed, fluctuation, more or less deep-seated, may be felt. This condition is usually accompanied by considerable febrile disturbance and much pain.

Treatment.—An early incision down to the mastoid

process right through the periosteum should always be made; this, in the early stage, relieves tension, and directly depletes the inflamed parts. In the later stages, when pus has been formed, it provides an exit for it, and thus prevents burrowing, which, by separating the periosteum from the bone beneath, is apt to result in exfoliation of the bone.

Previous to performing this operation the surgeon must carefully examine with his fingers the exact position of the mastoid process, so as to avoid the danger of wounding the important structures situated below it. The incision should be made vertically, about ¾ of an inch in length, and about ½ an inch behind the auricle. In doing this, the surgeon will often be astonished at the depth he has to penetrate before reaching the bone, and this may somewhat disconcert him. I have known a case where the surgeon feared he had opened into the cranium, and mistook the thick pus for softened brain matter. Again, as a rule, the posterior auricular artery is divided, and smart hæmorrhage is the result. This need not create alarm, nor should it be arrested, save in very exceptional cases, because usually it will be found that the smarter the hæmorrhage the greater the relief.

When the temporal fossa is also implicated, the incision should be made a little higher up, but still behind the auricle. This will give sufficient exit for the pus or serum, for occasionally the fluid is serous and not purulent. In these cases the incision must be kept open by means of a drainage tube, or by the daily introduction of a probe. Light pressure in the form of a pad put on over the temporal fossa after the incision, will prevent the cavity from refilling, and will accelerate the healing process.

Poultices constantly renewed should always be employed and continued until all signs of acute inflammation have subsided.

Some surgeons advise cold applications in the treatment of mastoiditis, but I am very averse to these. Again, leeches behind the auricle are often employed, but this method of depletion is not nearly so effective as the incision. A smart purgative, light diet and perfect rest are to be prescribed.

Sometimes this condition becomes chronic and there is a sinus leading from the mastoid process to the meatus, but as this practically involves the bone, its treatment will be taken with deep-seated mastoiditis.

Deep Mastoiditis.—Occasionally in the course of acute or chronic suppurative inflammation of the tympanum the air-cells of the mastoid process become affected through the extension of the disease.

Course and diagnosis.—Acute deep mastoiditis is characterised by intense deep-seated pain, with tenderness over the mastoid process, more especially when the part is percussed. There may be little or no swelling of the superficial tissues but frequently the whole of the outer bony wall is involved, and then we have all the signs of superficial mastoiditis already described, while the inflammation of the bone frequently results in perforation of this outer wall. Thus, we get an abscess appearing behind the ear which communicates with the mastoid cells; and this, when opened, allows of fluid to be syringed right through the mastoid cells, tympanum, and so, by the perforation in the membrana tympani, out through the meatus; and *vice versa.*

In these deep-seated acute cases the febrile disturbance is even more marked than in the superficial ones, and this is much more liable to be accompanied by some

signs of cerebral mischief, which may result in severe meningitis and death.

The inflammation often passes from the acute to the chronic stage, or indeed it may be chronic from its very commencement. We are then apt to get a carious cavity hollowed out in the substance of the mastoid process, which usually perforates the outer wall if this has not already occurred. But occasionally extension of the disease takes place in the opposite direction, and the lateral sinus becoming involved, a clot of blood is the result, and this may prove fatal in one of the three following ways :—

1. By exciting fatal meningitis.
2. By breaking up and producing pyæmia.
3. By producing a secondary abscess in the brain substance.

Treatment.—The treatment of the acute form is similar to that of the superficial variety. Some aural surgeons use leeches instead of making an incision, but I very much prefer the latter method as it depletes the deeper structures much more thoroughly and, as a rule, gives immense relief.

Should this, however, together with the poulticing, be found insufficient to allay the symptoms and the surgeon fears extension inwards, he should proceed at once to open into the mastoid cells.

This operation requires a certain amount of care on account of the close proximity of the lateral sinus, and also for this reason, a perforator (see Fig. 33) is preferable to the ordinary trephine.

Drilling the Mastoid—The patient being under the influence of an anæsthetic, a crucial incision should be made behind the auricle, so that its centre is about half an inch behind the meatus and on a level with it. The

surface of the bone should then be examined, and if there are any signs of softening, the point of the knife will be sufficient to perforate into the mastoid cells. But if there are no such signs, then a place for perforation must be selected, for which purpose I prefer taking the mastoid process itself as the guide, and perforating about its centre.

The perforator is first used as a drill or bradawl, the guard being fixed so that it cannot penetrate further than a quarter of an inch; if this fails to open into the

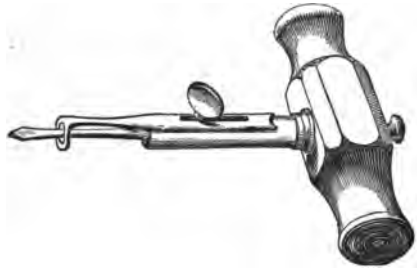

FIG. 33.—Mastoid perforator.

cells then either a dentist's elevator must be used to break away the bone, or a strong steel probe to break through. If these means still fail it is rarely wise to perforate much deeper, because in all probability there are no large mastoid cells present. And there can be little or no advantage in perforating the inner table of the skull, while there must be considerable danger in attempting to do so, for the bone in this position varies very much in thickness, and the lateral sinus may be very close.

In performing this operation on a child it must always be borne in mind that the mastoid process and air-cells are not nearly so much developed as in the adult.

Perforation into the cells in these cases does not always give exit to pus, nor indeed is this necessary in order to obtain the marked benefit which usually follows the operation; simple drilling of the bone substance itself being often sufficient to arrest the inflammation. Syme, Lister and other surgeons have pointed out the same thing in respect to inflammation of the tibia and other bones.

In acute mastoiditis this operation is almost always followed by a remarkable fall in temperature and great relief to the cerebral symptoms, and undoubtedly it is frequently the means of saving the patient's life.

Both the deep and superficial varieties of acute mastoiditis are liable to become chronic; this, perhaps, is more frequently the case with the former. Then we may get a sinus opening behind the ear, more or less freely connected with the cells and tympanic cavity in the former, and directly with the meatus in the latter, variety of the disease.

These cases are usually very tedious, and there is always considerable danger to the patient of extension inwards; and, being necessarily complicated with disease of the bone, this sometimes leads to necrosis of large portions or to extensive caries.

A free passage should be kept throughout the sinus by frequent syringing from meatus to wound, and from wound to meatus. And if the wound tends to close before the discharge and other signs of disease have disappeared it should be kept open by means of a drainage tube or by the frequent introduction of an oiled probe. Injections of warm water containing a little Condy's fluid, carbolic acid, or in some cases boracic acid, should be used. Sulphate of zinc may be added to the carbolic injection, or when the parts will bear it

the nitric and carbolic injection (see Appendix) is most serviceable.

If necrosis should occur the sequestrum or exfoliation should be removed as soon as possible. This can of course be done earlier than when the necrosis is in the petrous bone. If there is sub-acute inflammation blisters will often give considerable relief.

The same rules for general treatment must be applied in these cases as have been already described in the treatment of caries and necrosis.

CEREBRAL COMPLICATIONS :—

Meningitis.

Cerebral Abscess.

Slight cerebral irritation (probably meningitis) frequently accompanies acute inflammation of the tympanum or its adjacent parts, and is due to extension of inflammation to the meninges. This is characterised by severe localised headache, referred usually to the temporal or occipital region which may be tender on percussion; by fever with well-marked evening rise and morning fall; and if long continued, by wasting of the body generally.

Treatment.—Absolute rest in bed and perfect quiet are indispensable. These alone are often sufficient to allay the irritation and overcome the cerebral symptoms, but at the same time it is advisable not to trust entirely to them.

A smart purgative should be administered, especially when, as is frequently the case, the bowels are constipated.

Counter-irritation in the form of a blister behind the ear or at the nape of the neck is often of great benefit,

relieving the pain and other symptoms. Depletion, by means of leeches or by an incision made down to the bone (see p. 144) may sometimes be needed, but as a rule this is only necessary in the severer forms; a few days rest in bed with a blister and purgative being sufficient to remove an ordinary attack of cerebral irritation.

From the above it will be seen that the prognosis, in milder cases at least, is favourable; but of course the surgeon can never be certain that the mischief will not so extend as to produce severe meningitis or abscess in the substance of the brain.

In severer forms of meningitis all the symptoms above mentioned are aggravated while the fluctuations of temperature are often very marked, sometimes rising 4° or 5° at night, and falling to a similar extent in the morning.

Cerebral abscess.—Sometimes the inflammation runs a chronic course and then, in my opinion, there is more liability to abscess in the substance of the brain.

The symptoms in these cases may be so slight as not to be noticed by either the physician or patient, even when a large abscess already exists.

The mode in which the disease extends from the ear to the substance of the brain is not very clear at first sight; but on careful post-mortem examination the veins in the bone leading from the tympanum or mastoid cells and the venous sinus into which they open will be found filled with a solid clot; again, the veins leading into this sinus from the brain substance will also be found similarly affected. This shows that the infection first extends to the sinus from the veins of the bone and then the small cerebral veins become infected backwards, (*e.g.* against the current of the blood) until the brain

substance itself is reached; and here an abscess is produced.*

From the foregoing it will be seen that the site of the abscess will depend upon which sinus is involved. Affection of the lateral sinus will produce an abscess in the cerebellum, whereas a cerebral abscess may be caused by affection of the superior petrosal sinus.

It is almost needless to state that even in those cases where a cerebral abcess can be diagnosed with certainty, no treatment can be of any avail.

PYÆMIA. — Occasionally a case will end fatally through pyæmia being set up, either directly from the diseased bone, or from the breaking down of a venous clot in the lateral sinus, or in one of the smaller veins.

The scope of this work will not admit of any detailed description of pyæmia, therefore the reader is referred for this, and also for further information concerning meningitis and cerebral abscess, to works on medicine and surgery.

* This explanation I have adopted after careful post-mortem examination of several typical cases.

CHAPTER VIII.

DISEASES OF THE MIDDLE EAR CONTINUED.

NEURALGIA.—Neuralgia affecting the auditory apparatus, and more particularly the middle ear, does occasionally occur, although not so frequently as is usually supposed.

Causes.—Dental irritation is the most common; but any of those debilitating causes that are liable to set up neuralgia in other parts of the body—ague more especially—may produce it here.

Symptoms and diagnosis.—Pain of the well-known neuralgic type, usually affecting one side. This is often associated with neuralgia of the face and scalp on same side, and is frequently aggravated by coming into a heated atmosphere, with a tendency to get worse at night or at certain times of the day, or even sometimes taking on a distinctly periodic type.

It is readily diagnosed, under ordinary circumstances, from acute inflammation by the absence of all inflammatory signs and symptoms and by there being no lack of hearing power. But it must not be forgotten that certain cases of acute inflammation of the tympanum are accompanied by neuralgia and thus the severe pain is often continued while the inflammation is subsiding; in these mixed cases there may be much difficulty in recognising their neuralgic nature. Again, neuralgia is one of those diseases which are easily simulated, and this form of malingering is naturally very difficult to detect.

Treatment.—This should be similar to the treatment

of neuralgia in other parts of the body. Should any existing cause for it be found, such as a decayed tooth for example, that should be removed. This may be enough to arrest the neuralgia, but as a rule in these cases, as in all those where no reflex irritation can be traced, constitutional remedies are necessary. Quinine is the most valuable medicine for this purpose, especially where the neuralgia is due to malaria. Indeed, when no reflex cause is evident careful examination of the history of the patient should be made, as to whether his residence is or has been in an aguish district. For at times a patient, who has some other slight middle ear affection, will complain of occasional severe pain which may readily be ascribed to recurrent inflammation, whereas it is in fact due to malarious ague and will readily yield to the exhibition of quinine, cinchonine or arsenic. In the case of quinine I generally prefer to give 4 large (5 grains) doses—after an aperient—within 36 hours, and then to continue with smaller ones. Where quinine fails chloride of ammonium in 30 grain doses may succeed; or again tincture of gelseminum (10 minim doses) sometimes effects a cure; or in fact any of the regular anti-neuralgic remedies may be tried. When the neuralgia is due to debilitating causes tonics should be given.

Specific Affections.—The middle ear is undoubtedly affected by *rheumatism* and *gout*, often as demonstrated by the late Mr. Harvey, through their action upon the joints of the ossicles. The diagnosis is sometimes difficult, but the existence of these conditions in other parts of the body and the previous history of the patient are generally sufficient.

The treatment must be almost entirely constitutional,

but in cases of acute gouty inflammation the appropriate local treatment, (see p. 87) as already laid down, must also be observed.

Syphilis.—*A priori* one would expect that secondary syphilitic affections of the tympanum would be a very frequent complication in syphilitic pharyngitis; but this is not so, for they are of comparatively rare occurence.

When it exists, the various syphilitic conditions must be treated constitutionally in the ordinary way, together with naso-pharyngeal injections of a mild character, such as solutions of chlorate of potash, carbonate of soda or chloride of ammonium. Applications of nitrate of silver and of perchloride of mercury, or mercurial fumigations may be useful. The Eustachian tube must be kept open by means of Politzer's bag which is to be preferred to the catheter; for if the beak of the latter should enter the ulcer the cellular tissue might be inflated, producing pharyngeal emphysema (see p. 42).

In some cases suppurative catarrh is set up with perforation, &c. Then the treatment for ordinary otorrhœa must be observed and the addition of a mercurial preparation to the injections or instillations is advisable. (See Appendix).

Carcinoma.—Carcinoma of the middle ear is very rare, but occasionally a carcinomatous pharynx will produce middle ear affection from closure of the Eustachian tube. Its diagnosis, treatment and prognosis scarcely come within the scope of this work.

Obesity.—Obesity by itself or as a complication, will sometimes produce middle ear deafness from closure by pressure upon the Eustachian tube, as pointed out by the late Mr. Harvey. In fact the origin of the Banting

treatment was due to Mr. Harvey's having diagnosed Mr. Banting's deafness as resulting from obesity, and this being removed by suitable anti-corpulent diet, the hearing power was restored.

The essence of this anti-corpulent treatment consists in abstention, more or less complete, from fat-forming foods, such as fats, starches and sugars, as well as from malt liquors, effervescing and sweet wines; all of which favour the increase of adipose tissue. The amount of tissue-forming foods should be carefully kept up, and the necessity for bodily exercise insisted upon. Lastly, the administration of saline aperients once or twice a week to relieve the portal system, is a most important part of the treatment.

CHAPTER IX.

DISEASES OF THE PERCEPTIVE APPARATUS.

THIS portion of the ear is fortunately much less liable to disease than the rest of the apparatus, for from its inaccessibility the lesions are often very obscure, and their satisfactory treatment is most difficult.

Moreover, though the surgeon, by means of the tuning-fork, etc., can easily recognise the existence of a lesion in the preceptive apparatus, yet it is frequently impossible to diagnose between an affection of the nerve centre, the trunk of the nerve, and the internal ear.

Any disease of the brain involving the nerve centre will produce deafness more or less marked; and if there is much pressure, the soft portio mollis is readily destroyed, and permanent complete deafness results.

This latter is apt to occur in *cerebro-spinal meningitis* from effusion of fluid in the sub-arachnoid space, and in certain intra-cranial lesions which produce infantile convulsions. Some *fevers*, as typhus or typhoid, may produce temporary deafness by involving the auditory nerve centre; which condition must not be confounded with deafness from the suppurative catarrh which sometimes accompanies fevers.

Again, *cerebral tumours*, including *syphilitic gummata*, may impair or destroy the hearing power by pressure on the auditory nerve centre, or on the portio mollis. In such cases it may be exceedingly difficult to localise the seat of the disease.

The presence of symptoms pointing to disease of adjacent nerve centres—as interference with the sense of sight or of smell—will materially assist in the diagnosis; as also will the existence or otherwise of a syphilitic history or syphilitic lesions in other parts of the body. In these latter cases anti-syphilitic treatment should be employed; *i.e.*, large doses of iodide of potassium (10 to 30 grs.) or small doses of perchloride of mercury (liq. hydrarg. perchlor. ♏xx), either of which it may be necessary to continue for many months.

Sometimes *fracture of the base of the skull* will produce more or less complete loss of hearing through hæmorrhage and consequent pressure at the base of the brain. This pressure very frequently is not sufficient to destroy the portio mollis, and the patient gradually recovers his hearing; therefore in these cases an unfavourable prognosis should not be lightly given during the first few months after the accident; but should no improvement be manifested within six or nine months the prognosis is very bad.

It is in cases of this nature that faradisation has been said to do good. But although I should be inclined to try it if the hearing power did not return by the end of two or three months, yet my experience of its use has hitherto been very discouraging. In fact no active treatment on the part of the surgeon is likely to be of service.

Congenital malformations of the auditory nerve or nerve centre account for a very large proportion of cases of the so-called deaf and dumb. The defect in hearing may be caused by the arrest of development or by some lesion in intra-uterine life, and thus it is that congenital deafness is often associated with lack of

intelligence, and that a certain proportion of idiots are quite devoid of hearing power.

The diagnosis of *deaf-mutism** from any of the above causes is a very simple matter, it being generally quite evident to any observant person, although reference is constantly made to the surgeon to decide the question. Frequently, however, in a congenital case, parents do not discover the deafness of their child until it is old enough to begin to talk; and indeed, even with the most careful parents, the defect is rarely noticed before the infant is about a year old. This often leads them into the error of supposing that the child could hear up to a certain age, but that it had afterwards lost the power of doing so; and in these cases it is sometimes difficult to diagnose between congenital deafness and some cerebral lesion occurring during the first eighteen months.

To ascertain the existence of complete deafness such loud sounds should be used for tests as are not accompanied by any shaking of the floor or violent movement of the air which may be felt by the child. Thus, stamping or slamming a door form no test whatever, whereas a shrill whistle (care being taken that the air does not fall on the child), or a bell sounded behind its back, are perhaps the best means of ascertaining whether or not the child is completely deaf. The tuning fork applied to the skull is of but little value as a test, not only because the attention of the infant will be attracted by the contact, but also because it may possibly feel the vibrations without hearing them.

If a sound, like that of a shrill whistle or bell, calls forth no notice from the child, that will be practically

* It must be borne in mind that occasionally severe middle ear disease alone will result in such marked deafness that, if the patient is young, he may become a deaf-mute.

sufficient to prove that the case is one of nerve deafness (the auditory nerve in some part of its course), and should there also be an absence of any signs of middle and external ear affection, the proof may be regarded as conclusive.

It is almost superfluous to say, that in cases of complete nerve deafness, medical or surgical treatment is nearly always out of the question. The prognosis is, as a rule, most unfavourable. But occasionally in young deaf-mutes—more often where some slight amount of hearing power yet remains—we do find that Nature, by gradually repairing some former mischief, restores the parts affected sufficiently to enable the patient to hear well enough to acquire speech in the ordinary way. But this work of reparation rarely takes place unless there are signs of it before the child is five years old, and no known method of treatment will induce or hasten it.

Affections of the Internal Ear.—These may be due to one of the following causes.

1. Pressure exerted on the fluid of the labyrinth.
2. Inflammation.
3. Congenital syphilis.
4. Mumps.
5. The effect of drugs.
6. A certain undetermined lesion producing the disease known as Menière's disease.
7. Exposure to constant jarring noises (Boiler-maker's deafness).
8. Senile changes.

1. **Pressure on the labyrinthine fluid** may be due to several causes. Thus, a foreign body or plug of wax pressing upon the membrana tympani may cause pres-

sure on the labyrinthine fluid through the chain of ossicles and plate of the stapes. Under ordinary circumstances this would be compensated for by bulging of the membrane of the fenestra rotunda; but when this is prevented by chronic thickening, etc., or when the pressure is more than sufficient to be counter-balanced by the bulging, then the internal ear may become affected. Thus, in cases of long standing tympanic catarrh where the perceptive apparatus has become defective, I think that probably this is due to the pressure of the stapes not being compensated for by the bulging of the fenestra rotunda, owing to its having become thickened by the catarrh.

In some cases of chronic catarrh of the tympanic cavity, alteration of the pitch is noticed; so that the same tuning fork applied to the two ears appears to strike a higher note in the one than in the other. This is due, I believe, to the altered tension of the labyrinthine fluid from pressure of the stapes as already described.

Besides producing disturbances of the hearing portion of the internal ear, the pressure sometimes affects the posterior labyrinth, and then vertigo may result. Thus, the mere act of syringing, especially when there is a large perforation of the membrana tympani, will frequently produce giddiness, sometimes with distinct rotatory sensations. Now and again a plug of wax or foreign body may occasion all these symptoms, and the patient might at first be supposed to be suffering from Menière's disease proper, but on removal of the obstacle these symptoms will disappear.

2. **Inflammation.**—Inflammation confined to the internal ear is very rare, but it sometimes occurs without any inflammation at all in the tympanic cavity. In such cases we have deep-seated pain, usually very severe; but all signs of tympanic affection are absent.

Giddiness, staggering, nausea and vomiting are present, and marked tinnitus. The deafness, as a rule, is complete on that side, and the tuning fork test shows that the skull-hearing is diminished instead of being exaggerated as in tympanic affections.

In the course of suppurative catarrh of the tympanum, whether acute or chronic, the inflammatory condition will sometimes extend to the internal ear.

Occasionally where there is severe or prolonged tympanic inflammation, as in scarlet fever, there may be loss of the stapes which necessarily results in total destruction of the internal ear, and this is probably the most frequent cause of the complete deafness met with after scarlet fever. Such cases are of course rare, but it is not at all uncommon for acute inflammation to extend from the middle to the internal ear, thus producing more marked deafness, considerable tinnitus, vertigo with rotatory sensations, nausea and vomiting. The vomiting is frequently a very marked symptom, and will sometimes continue for twenty-four hours or more, leading the physician to fear cerebral complication. But the long continuance of this vomiting, and the presence of vertigo and tinnitus together with the signs of middle ear mischief, are usually sufficient to enable him to diagnose the seat of the mischief.

In these cases complete rest with blisters behind the ear, and two or three leeches in front, together with a smart purgative, form the chief methods of treatment upon which I rely. Besides these, I frequently give large doses (40 min. to 1 dr.) of hydrobromic acid to quiet the nerve irritation.

Prognosis.—In inflammation of the internal ear the prognosis must be very guarded. As a rule some amount of permanent loss of hearing is the result; while

5. **The effect of drugs.**—Certain drugs, but especially quinine and salicine, appear to have a direct influence on the internal ear, large doses of these producing tinnitus and deafness. These results, however, almost invariably pass off after a time, although in some few cases prolonged use of large doses has been followed by a considerable amount of permanent deafness. The mode in which they act is not really known, but arguing by analogy from the effect of quinine on the retina, it is generally presumed that the drug produces anæmia of the labyrinth, in the same way as it certainly does anæmia of the retina. But whereas the effect upon the ear is almost always of a most transitory character, that on the eye is more permanent; at least, so we are informed by eminent ophthalmic authorities.

This action of large doses of quinine has led some aural surgeons to be very chary in the use of this drug, even as a tonic in small quantities. This, I think, is a mistake.

6. A certain undetermined lesion producing a disease known as **Menière's disease** or **labyrinthine vertigo.**

The late Dr. Menière of Paris was the first to distinguish this affection of the posterior labyrinth (semi-circular canals and utricle), and his observations have been more or less corroborated by many later authorities both in pathology and physiology.

It is now universally recognized that the train of symptoms known as Menière's disease is due to some lesion in the posterior labyrinth. But as there is some confusion with regard to what is meant by Menière's disease, I prefer drawing a distinction between Menière's symptoms or symptoms of irritation of the semi-circular canals, produced by some external influence such as

pressure or extending inflammation, and Meniere's disease proper which appears to run a more or less definite course.

Meniere's symptoms.—These have already been alluded to from time to time as a complication of other diseases. They consist, when fully developed, of marked tinnitus, usually of an accentuated character; of vertigo with rotatory sensations and consequent staggering movements on the part of the patient; nausea and vomiting.

The rotatory sensations will depend for their direction upon which of the semi-circular canals is affected. Thus, pictures on the wall may appear to move round from right to left, or from left to right; or the floor may seem to rise upwards or fall downwards, from side to side or from before backwards; so that the patient may tend to fall to the right or to the left, to pitch forwards or to fall backwards, sometimes giving the patient a sense of lightness, or he may describe a fancied feeling of looking over the top of a house. Again, a very common symptom is that of appearing to sink backward into space. All these sensations are aggravated by turning the head, more especially when it is turned in such a direction that the axis of the specially affected semi-circular canal, is in the same plane as the axis around which the head is moving. That is to say, it sometimes happens that while no giddiness is produced by movement from right to left of the head in the ordinary position, yet if thrown backwards and the body moved from right to left vertigo is the result. As a rule the affected side is that towards which the patient tends to fall.

The vertigo and rotatory sensations are sometimes sufficiently sudden and severe to make the patient really

fall, but usually they are not so great as this; and in the milder forms he will simply describe the act of walking as if he were on board a ship at sea. And indeed, I may here call attention to the marked similarity that exists between Menière's symptoms and sea-sickness, which latter otologists generally consider to be chiefly the result of semi-circular canal irritation.

Nausea and vomiting are usually present in this disease and sometimes the vomiting is very persistent.

When Menière's symptoms occur as a complication of some other condition, the treatment must be directed chiefly to the cause as, with its removal, the resulting vertigo will also disappear. For example, when a plug of cerumen pressing upon the membrana tympani produces vertigo, the removal of the plug will arrest it. In the same way, in inflammation of the tympanum extending into the internal ear it will rarely be necessary to do more than to treat it in the manner laid down for such inflammation (see pp. 90, 161), although occasionally the semi-circular canal irritation continues after the exciting cause has passed away. When this is so it must be treated as a case of Menière's disease now to be described.

Menière's disease proper appears to me to be a definite disease, as originally stated by Dr. Menière. Although we are rarely able to assign a cause for this condition, yet undoubtedly a low state of health is a predisposing cause, as we meet with patients who may have had one or two of these attacks in a long period of years, and each time it has occurred just when their constitution had suffered from some debilitating condition. Again, I believe I have, in some cases, traced it to a gouty origin; but as already stated, in by far the majority of cases no sufficient reason for it can be discovered.

Course and symptoms.—The disease is characterised by attacks of Menière's symptoms already described coming on at regular or irregular intervals, something like epileptic attacks. In the intervals the patient usually feels quite well although there may be some tendency to vertigo. A typical seizure commences with a sudden tinnitus of an accentuated character soon followed by vertigo and rotatory sensations, and later on, by nausea and actual vomiting.

These attacks on passing off, leave the patient feeling quite well, unless the vomiting has been excessive. They may be mild or severe, lasting from a few minutes to several hours, recurring once in two or three months or as often as two or three times a day.

In the earlier stages there is usually no deafness, but as the disease advances, the patient notices that he is somewhat deaf during the attack, and later still there is a certain amount of permanent deafness which the tuning fork shows to be due to internal ear affection. Eventually, if the disease runs its full course, the hearing is entirely lost, the attacks become less frequent and less marked until they finally disappear altogether, or only leave behind a tendency to occasional slight vertigo. The disease, as a rule, takes two or three years to run its course, but it may be arrested at any period, and then the hearing usually remains *in statu quo*, although sometimes it actually improves.

Diagnosis.—Menière's disease is frequently mistaken for epilepsy, cerebral disease and biliousness. In fact, it is of much more frequent occurrence than is usually supposed, although, if the case be carefully examined, its diagnosis is by no means difficult.

It is *distinguished from epilepsy* :—

1st. By the absence of convulsions; the existence of

which would alone show that the case was not simply one of Menière's disease.

2nd. By the absence of drowsiness after the attack. The stomach derangement, &c., produced by the prolonged vomiting must not be confounded with the drowsiness that comes on after an epileptic fit.

3rd. By there being no loss of consciousness. Should there be loss of consciousness this would be conclusive evidence against its being uncomplicated Menière's disease.

Attention to these three points are generally sufficient to enable the surgeon to arrive at a correct diagnosis; but, for further guidance, there is also the peculiar tinnitus which is very characteristic of this disease; the rotatory sensations; the nausea and vomiting; the irregularity, both in the duration and the recurrence of the attacks; the possible presence of some vertigo between-whiles; and in most cases, the internal ear deafness.

The only times when there is any difficulty in diagnosis are in some slight attacks of Menière's disease, which may be confused with the '*petit mal*' of epilepsy.

To distinguish from brain disease—This may be very difficult when the nerve-centres of equilibration in the cerebellum are affected, because in this form of brain disease all the Menière's symptoms are at times present. But, as a rule, when it is the result of a cerebellar lesion, the symptoms are more permanent and less regular in their recurrence, besides being more marked and persistent. Again, if due to brain disturbance, other nerve-centres are almost invariably affected which thus give rise to further symptoms, thereby pointing to brain lesion.

To distinguish from bilious attacks.—Although nothing

is more common than confusion of these two, yet Menière's disease may be easily diagnosed from biliousness by absence of headache; by freedom from malaise, both immediately before and after the attack; by the rotatory sensations, the peculiar tinnitus, and by the deafness, if present.

Between the attacks the diagnosis may be assisted by trying the effect of sudden rotation. Thus, if the physician twists the patient's head sharply in the axis of the semi-circular canal affected vertigo will result.

Treatment.—Menière's disease proper will often yield to appropriate treatment.

In very chronic cases large doses of quinine will sometimes yield very good results (Charcot); but personally, I have found far more benefit derived from the use of bromine in some form, and from salicylate of soda. Roughly speaking, 70 or 80 per cent. of these cases are more or less completely arrested by bromine, either in the form of a bromide, or, better still, of hydrobromic acid. But occasionally salicine or salicylate of soda will arrest the disease when bromine has failed. At times the effect of the bromide or hydrobromic acid is instantaneous; as, for instance, in the case of one of my patients, an otherwise healthy young man, in whom the vertigo was brought on by the least movement of the head. After a single dose of bromide of potassium he was able to turn his head without giddiness, and a continuance of it for six weeks completely arrested the disease.

I prefer the hydrobromic acid as being far less liable to depress both mentally and bodily. I usually give from 30 minims to 1 drm. three times a day; sometimes even as much as 1½ drms., the small doses ordinarily advised not being sufficient. If salicylate of soda is used, 10 to 15 grs. three times a day should be given.

These medicines may be combined with tonics when their use, as often happens, is indicated. The general health should be carefully maintained in every possible way on account of the tendency, already noticed, of debility acting as a predisposing cause. Should a gouty diathesis be present, suitable treatment must be adopted and a strictly anti-gouty regimen enforced.

Prognosis.—If allowed to run its course, the disease, as already stated, tends to wear itself out after the functions of hearing and probably of equilibration have been destroyed, and then no manner of treatment is of any use. But if the disease is taken early, it may generally be arrested, if not cured by treatment; the hearing, if affected, remaining *in statu quo*, or, in some rare cases, actually improving. There is, however, considerable tendency to relapse, even after many years, should the patient become debilitated from any cause whatever.

7. **Boiler maker's deafness.**—It has long been known that boiler makers, who are subjected to the constant din of hammering inside boilers, are very liable to become deaf, and many explanations of the pathology of this affection have been given.

Professor Politzer has suggested that the constant loud vibrations may produce some loosening of the joints of the ossicles, and thus the chain, as a conductor, is impaired. But though this explanation may be, to a certain extent, correct, yet undoubtedly it cannot be accepted as the chief cause of the deafness.

For it has been pointed out by aural surgeons practising in the ironwork districts, that the defect is chiefly in the internal ear, as shown by the tuning-fork and other tests. I have been able to confirm this, having carefully examined a certain number of such cases, in

all of which I found that the internal ear was the chief seat of the mischief, although, except in early stages of the disease, the middle ear was also involved.

The following three cases will serve as illustrations:—

D. K——, age 50. Has been working in boiler maker's shop 30 years. Began to get deaf 5 years after he commenced work. No increase of deafness for the last 10 years. Hears ordinary distinct conversation at several yards; a 50 inch watch not heard on either side, even on pressure against the ear. Tuning-fork on bridge of nose heard 0″ (the normal length of time). These test results point distinctly to the existence of both internal and middle ear affection; the effect of the one being exactly counterbalanced by the effect of the other, so far as the tuning-fork is concerned. (See p. 50). No doubt the middle ear affection in this case was partially catarrhal, for after Politzerisation the tuning-fork was heard ¼″ minus.

W. P——, age 57. At the works 37 years. Deafness began 25 years after commencing the work. Gradually becoming worse. Hears direct conversation at several yards; hears the watch on touch by left ear, but not even on pressure on right side. Tuning-fork 3″ minus. After Politzerisation 5″ minus. This is a more typical case, and one in which the middle ears were only slightly affected.

H. F——, age 17. At work 2 years. Getting deaf ever since commencement. Hears distinct conversation at many yards. Watch, left side $\frac{2}{50}$; right side complicated by perforation and otorrhœa. Tuning-fork on nose 0″.

Here again, the internal ear affection compensated, so far as the tuning-fork was concerned, for the effect of the middle ear mischief. In this case there were also signs of chronic middle ear catarrh.

These three cases demonstrate, I think, that the internal ear is the chief seat of the mischief, and no doubt this defect is due to the constant jarring. Mr. Hewetson of Leeds very aptly likens it to the effect of prolonged exposure of the eye to direct sunlight. In each case the nerve is partially paralysed, and on continuance of the cause, permanent impairment is the result.

As regards treatment, nothing but complete change of occupation appears to be of any use. Frequently when the patient is entirely removed from the source of the mischief, the hearing power gradually improves.

8. **Senile changes.**—As old age approaches, the hearing power tends to diminish, this tendency being much greater in some persons than in others, as it does not necessarily follow in the same proportion as the degeneration in other parts. Thus the aural surgeon is frequently consulted for deafness by very old people who are much more vigorous than their years would imply, being physiologically speaking, younger than their age.

These senile changes are partly tympanic as already noticed (see p. 109), but they are also partly labyrinthine and nervous (auditory nerve and nerve centre). That they are due, to a great extent, to changes in the perceptive apparatus is shown by the tuning-fork test, for in these cases the skull hearing power is considerably diminished in spite of the signs of tympanic affection.

In senile deafness the tuning-fork test is of great value, because in those where the skull hearing is much diminished, even though there may be considerable middle ear catarrh, the prognosis is bad, and treatment will be of little or no avail.

CHAPTER X.

EDUCATION OF SO-CALLED DEAF-MUTES.

It must be distinctly understood that the defects of the auditory apparatus have no influence, except indirectly, upon the organs of speech. Although it is true that a person who has not had sufficient practice in the art of speech before becoming deaf, may lose that art completely—as indeed is usually the case when deafness has come on before the age of seven years, or even somewhat later—yet we must remember that this condition is not the result of organic change, but simply a natural consequence of the person's inability to imitate the voice of others and to appreciate the results of his own efforts of articulation. With little children these do, no doubt, form an almost insurmountable obstacle to their acquirement of speech, for imitation is to them the best mode of tuition, and their difficulty in producing sounds they cannot hear is extreme.

Until a few years ago most people in England, the United States and our Colonies, considered it as practically impossible to teach speech to the deaf, and hence these were described as deaf-mutes or deaf and dumb, a term not, however, scientifically correct. That this view was erroneous is shown by the fact that instances did occur, both in England and in other countries, as far back as the middle of the 7th century, where the 'deaf and dumb' were taught to speak. Gradually this possibility became more and more acknowledged, and methods of instruction were organised and de-

veloped, more especially in Germany; where between 1760-1778 it became the National System. The practice has, since then, spread all over the Continent with, perhaps, the exception of Belgium, but even there it now seems to be making way.

This, the German, or pure oral system, so-called in contra-distinction to the French or sign system, demands great skill, patience and method, on the part of the teacher, and earnest perseverance on that of the pupil; but the extreme value of the art when acquired, breaking down, as it does, the blank wall of separation between the heretofore deaf-mute and his fellow-men, more than repays the many years of patient labour.

It does not come within the scope of this work to describe the methods employed in the German system, but I may say that it consists mainly of training the pupils to produce, first the simpler and gradually the more complex articulate sounds, by watching the motion of the lips and tongue. When all the sounds necessary to the language have been mastered they are formed into words, and the meanings of these words taught by objects, models, pictures, actions, &c.; until at length the child is able to express his ideas by speech and to understand what other people say by lip-reading. The latter circumstance has caused this method to be sometimes styled the 'lip-reading system.'

This speech education is carried on concurrently with the general education of the child. All use of signs is forbidden, as otherwise the pupil, preferring the easier method, will not be likely to exercise that patience and perseverance that are absolutely necessary to enable him to overcome the difficulties of the German system. I am told that a child may begin to be taught between the ages of 5 and 6, but where only a limited number

of years for school education is possible it would be wiser to commence a couple of years later. In cases of congenital or infantile deafness, seven or eight years should be devoted to the training; but when deafness has come on after the child has learnt to speak a much shorter time will suffice, as he will only require to be initiated in the mysteries of lip-reading.

Modulation of the voice cannot be acquired, it is true, and hence the speech of educated deaf persons is necessarily inferior to that of ordinary individuals; but, nevertheless, the amount of success achieved by this method is most remarkable, pupils well trained being enabled to converse quite readily, and in a manner to be well understood. They are no longer shut out from intercourse with the world around them, and this incalculable blessing can hardly be over-rated.

When surgeon is applied to for advice as to which method is to be adopted in any individual case, the following suggestions may serve to guide him in the formation of his opinion.

1. In all cases where deafness has come on after speech has been acquired, lip-reading should be taught, unless the patient is either too old or too much confirmed in the use of signs. For I may here remark that teachers of the German system appear to be agreed that its difficulties can rarely be overcome by adults who, having already been deaf for years, are thoroughly confirmed in the habit of using signs. With children and young adults who have only recently lost their hearing the study of lip-reading is strongly to be recommended, and it is also well to insist upon the necessity of the patient reading aloud for one or two hours daily, to prevent the art of speech being lost.

2. Persons who are born deaf, or who have lost their

hearing so early that they have never learnt to speak, may be divided into two classes—those who possess ordinary intelligence, and those who are more or less deficient in intellect. For the former the use of the German system should undoubtedly be urged, but for the latter no such rigid rule can be laid down. Unfortunately, congenital deafness is frequently accompanied by more or less intellectual deficiency, and when such is the case the French sign system may be preferable because it is more easily acquired, especially when the lack of intelligence is so great that it amounts to idiocy.

It is only fair to add that enthusiastic supporters of the German system deprecate the idea of anyone being excluded from its undeniable benefits, and they earnestly advocate that a fair trial should, at least, be given to every deaf person. But while recognising to the full its enormous advantages, we must not shut our eyes to the fact that at present there are many grave difficulties in the way of its universal adoption, first and foremost of which is the necessarily large expenditure of time and money, both serious items among those whose weekly earnings are but small. There are, it is true, a few Board Schools in London where the German system is taught, but practically these are available only for the poor who live in the district; for although there are some semi-charitable boarding institutions connected with them, but few of the working classes can spare the money that is required for the extra expense entailed by their child being boarded out.

The time may come, and we sincerely hope that it soon will, when the nation at large shall become more fully alive to the duty of helping those of its citizens who are so heavily handicapped in the race of life by the terrible infirmity of deafness, and then we shall

have state aid given and no one will be shut out from communication with his fellows on account of not being sufficiently rich to avail himself of this most valuable, but necessarily expensive, mode of education.

CHAPTER XI.

HEARING BETTER IN A NOISE—TINNITUS AURIUM—ARTIFICIAL AIDS TO HEARING.

HEARING BETTER IN A NOISE, or PARACUSIS WILLISIANA.* As already noticed while discussing advanced middle ear diseases, certain patients undoubtedly hear better in a noise. That is to say, such patients will hear conversation far more easily either when church bells are ringing, or when riding in an omnibus, train, or other rattling vehicle, than they would in a quiet room. And though this, no doubt, is partly due to our naturally raising the voice under such circumstances, yet it has been proved by Politzer and Roosa that there is besides an actual improvement in the hearing power.

In all probability the chief reason of this improvement is that these loud noises do not interfere with a deaf person so much as with an ordinary individual. I believe that loud noises prevent us from hearing because they cause a jar upon the internal ear; and therefore if a person's middle ear is defective, the vibrations being conducted less perfectly the jarring effect is not so great. The following little experiment will bear out this suggestion. If anyone with normal hearing, when travelling in a rattling vehicle,

* This was first described by Dr. Thomas Willis, *Opera omnia*, Amstelædamia, apud Henricum Wetstenium. Pars Physiol., Cap. xiv., p. 69.

will lightly close his ears with his fingers (thus, as it were, simulating a defective middle ear as regards its conducting power), he will lose much of the jarring noise, and be enabled to hear quite as plainly as when his ears are unstopped. The louder the jarring noise the more marked this phenomenon will appear, and if for instance, we make the experiment in a boiler maker's shop, the result is most striking, conversation being heard far more pleasantly and with much greater distinctness than when the ears are unstopped. Professor Roosa of New York, at the Otological Congress (Basle, 1884), said that he was convinced that all persons suffering from middle ear deafness hear better in a noise. Now if my explanation be correct this statement will only apply to cases of severe middle ear deafness; that is to say, where the middle ear affection is sufficiently marked as to preclude the jarring effect of loud sounds from passing through on to the internal ear. And this theory is further borne out by the fact that persons afflicted with *internal ear deafness* do not experience this improvement under similar conditions; on the contrary, even moderate noises interfere with their hearing power, as already noted by Professor Roosa. For further information on this interesting subject the reader is referred to Roosa's *Diseases of the Ear*, sixth edition, pp. 22, 355.

TINNITUS AURIUM.—Noises in the ear are, of course, merely a symptom of disease due to some disturbance of the function of hearing, as already noted in the introduction. It might therefore seem to be as much

out of place to treat tinnitus aurium by itself as to speak separately of the symptom of deafness; but for many reasons I think it will be practically useful to say something concerning it as a whole.

Various authors have divided noises in the ear in many ways, none of which seem to me to be quite satisfactory. Indeed, I do not think it possible to separate the different kinds by any sharp line of demarcation, though for purposes of description they may be roughly grouped together according to the following characteristics:—

1. Clicking (from muscular spasm).
2. Pulsating (synchronous with the pulse).
3. Rushing, blowing, and hissing noises.
4. Musical.
5. Voices.

Clicking tinnitus is an objective form of noise, and can be heard by the observer as well as by the patient; in fact sometimes, when very loud, it may be detected at a distance, although at others it can only be distinguished by the surgeon by means of the diagnostic tube. The clicking noise may perhaps be more fitly described as being like the sound produced by the winding up of a watch. In some cases it can be voluntarily produced, but as a rule it is not under the patient's control. This is one of the rarest forms of tinnitus, although most aural surgeons have met with cases of it now and again. It has been fully described by Dr. Burnett and others; and Dr. Fitzgerald of Dublin read an interesting paper on the subject at the International Medical Congress, London, 1881 (p. 44, *Trans.*).

The clicking noise is distinctly not synchronous with the heart, and is apt to cease altogether for a time, and then come on again without any apparent reason. It is

due to spasmodic contraction of one or more of the muscles of the palate, and this, acting on the pharyngeal opening of the Eustachian tube, causes a valve-like opening and shutting, and so produces the noise. There must also be some catarrh present, rendering the surfaces of a somewhat sticky nature.

This form of tinnitus has been ascribed to spasmodic action of the tensor tympani and stapedius muscles; but, though it is possible that spasm of these muscles may produce some form of tinnitus, the one in question is undoubtedly due to palatal spasm, as just stated. I have noticed that spasm of the orbicularis and of other facial muscles is sometimes associated with this affection.

The treatment should be directed first to the catarrhal condition, which as a rule soon yields sufficiently to arrest the tinnitus; and secondly, to the spasmodic affection itself. This must be treated by nervine tonics, cold douches, and other bracing regimen, as the case may indicate.

Pulsating tinnitus, strictly speaking, must in all its varied forms be considered objective, although it is only audible to the surgeon in a very few cases by the aids which we have at present.

Occasionally this pulsating tinnitus is an accompaniment of a cardiac bruit; or again, the bruit of an aneurism in the neighbourhood of the ear may be the source; while sometimes, in chlorosis, a venous murmur will be heard by the patient. The noise may be audible to the surgeon by means of the stethoscope in such cases, but these are the rarer instances of pulsating tinnitus. More frequently, this peculiar throbbing (synchronous with the pulse) is met with in congestion of the middle or the internal ear. The treatment of this tinnitus must be the treatment of the condition produc-

ing it. But there is a form of pulsating tinnitus—due probably to some vascular disturbance of the middle or internal ear—which is said to be considerably modified, if not cured, by the use of hydrobromic acid (Woakes); although I must own that, as a rule, where I have tried it, even in large doses, it has failed to yield satisfactory results.

In connection with this part of our subject we may note the effect of certain drugs, which are apt to produce tinnitus, probably through the medium of the circulation in the internal ear. Large doses of quinine or salicine are well known to act in this way, but as the effect, as a rule, passes off after the use of the drug is stopped, it does not call for any special treatment.

Rushing, blowing, hissing.—In this group, which is by far the most common, I include a large number of noises which possess one or other of these characteristics. Thus, the tinnitus may be described by the patient as being like blowing off of steam, hissing of a tea-kettle, murmuring of the sea; as rustling, or even as shrill whistling, &c. When the noises are not very great they are only noticed when the patient is in quiet surroundings, and he will frequently say that he only hears them in bed.

It is very difficult to make out the exact cause of these noises, but the following consideration will serve as a guide. A disturbance of any portion of the auditory apparatus which is like the disturbance produced by a real sound, will give rise to tinnitus resembling that sound. Thus, lightly brushing the membrane will produce a sense of great noise, because the brushing causes a vibration similar to that which is produced by a great noise. Syringing the ear will produce the same effect for a similar reason. Again, pres-

sure, direct or indirect, on the nerve-endings, is not felt as such but perceived as sound. In fact, in my opinion, the commonest cause of tinnitus is the result of such pressure; and in support of this I may call attention to the great tendency that there is to it in chronic tympanic catarrh (where there is pressure exerted on the internal ear), while in chronic otorrhœa with large perforation there is far less tendency to it.

There is a peculiar form of tinnitus which is very characteristic of Menière's disease; it consists of a sort of musical ring which becomes accentuated and intensified ("goes off *ping*" as the patient calls it) at the commencement of an attack of vertigo. This is due, I believe, to increased tension in the internal ear.

Certain diseases, too—gout, and possibly rheumatism—seem to act as predisposing causes of tinnitus.

Treatment and prognosis.—The treatment of all this group must, like the preceding, be chiefly that of the condition that causes them, but I am sorry to say the results are rarely satisfactory.

The continuous current was at one time much recommended, and in a certain number of cases its effect is greatly to diminish or entirely to remove the tinnitus. But unfortunately the improvement only remains so long as the current is applied; hence its use has been almost abandoned.

Suction, by means of Siegle's pneumatic speculum, or a simpler but similar suction apparatus, has been found to relieve tinnitus for the time, but no greater benefit seems derivable from this than from the use of Politzer's bag.

Incision of the membrane, with or without further operative interference, such as the division of the tensor tympani tendon, has been recommended by various

German authorities, but finds little or no favour in England.

From time to time various drugs have been suggested and used for their supposed direct effect on the tinnitus. The late Mr. Hinton strongly recommended a trial of chloride of ammonium internally; but the drugs most used for the purpose at the present time are, perhaps, the bromides and hydrobromic acid.

In cases of gouty diathesis, iodide of potassium and bicarbonate of potash, together with an anti-gouty regimen, will sometimes afford relief.

Professor Burckhardt-Merian has found very good results from the inflation of the vapour of the iodide of ethyl.

When tinnitus occurs in a case of chronic tympanic catarrh there is always more probability of improving the hearing than of getting rid of the noise. Where it comes on at a very early stage in the catarrhal disease (perhaps before the patient suspects the existence of any deafness) it may yield more readily to treatment, but even then the tinnitus will often remain after the hearing power has been restored.

In some confirmed cases these noises are so distressing that they lead the patient to fear brain mischief, and to talk of suicide.

Musical.—Occasionally the tinnitus assumes a musical form, from ringing of bells up to actual tunes. Sometimes the patient will recognise it as a repeat of music heard a few hours before. I regard this as a similar form to that of the preceding group.

From the foregoing it will be seen that disease of the auditory apparatus may produce tinnitus, and this may assume one of the forms previously described. And although there is some difficulty in making a correct

diagnosis, yet, should there be distinct evidence of aural disease and none of the brain itself, I think we are justified in assuming that the tinnitus is the result of the former, and in assuring our patients that there is no fear of brain mischief resulting therefrom—a fear which is almost invariably present in their mind, although they will not always own to it.

Voices.—But occasionally we meet with another form of tinnitus which may be most distressing. The patient seems to hear a voice, perhaps, mocking each word he utters, or repeating sentences over and over again, frequently adding bad language, and sometimes almost driving him to despair.

I am strongly of opinion that in these cases there is always, or nearly always, disease of the brain. This is probably accompanied by aural disease; and that disturbance which, in a sane person, would produce one of the ordinary forms of tinnitus, now becomes translated, as it were, into language, and so gives rise to these whimsical and distracting hallucinations.

AIDS TO HEARING.—The surgeon is frequently required to give an opinion upon the relative advantages to be derived from the various forms of ear trumpets, etc., in individual cases, and it is therefore important to consider carefully the *modus operandi* of these instruments so as to ascertain whether, in the case before him, any real help can be given through their agency. This is the more necessary as there is so much deception practised among what I may call "quack vendors," who are ready to

Audiphones.—Some seven years ago Mr. Rhodes, of the United States, brought out an audiphone, which consisted of a fan-shaped plate of vulcanite, rendered tense by bending. The teeth being applied to the upper edge, the sound-waves which strike upon it are picked up and carried, through teeth and skull bones, to the internal ear itself, the audiphone thus being utilised as a veritable artificial tympanum.

A few months before Mr. Rhodes published an account of this instrument, I had succeeded in making a somewhat similar one. Mine consisted essentially of the vibrating tympanum, similar to that of the phonograph, with a long style that did duty for the chain of ossicles or columella, the end of which was to be applied to the teeth. I was at first greatly delighted with the result of this contrivance, for a deaf patient who tried it, found that it enabled him to hear conversation quite easily. But I soon discarded any idea of suggesting it for general use, as for a long time it was only in the case of this one patient that I found my audiphone to be helpful, while in almost all others greater assistance was given by the ear trumpet.

On testing Rhodes' instrument, which is far more convenient, I found that it acted equally well but no better than mine. Later on, Professor Colladon of Geneva, suggested the use of a piece of stiff cardboard applied like Rhodes' audiphone, and this I have found to be preferable to both the others. Unfortunately Rhodes has patented his instrument, and therefore the cardboard one cannot be sold.

It is a great pity that the audiphone cannot be so perfected as to make it of general use in all cases of middle ear deafness; for it may fitly be regarded as a great triumph from a scientific point of view, as by it

we are enabled to pass articulate sounds direct to the internal ear thereby replacing, when necessary, a defective conducting apparatus. But as it now stands, the audiphone is only of real use in about one in every thousand cases of marked middle ear deafness.

Dentiphone.—This is a form of audiphone, circular in shape, in which the centre of the vibrating disc is attached to the teeth by means of a string. It is of less value than the preceding.

A conducting rod passing from teeth to teeth, or from the larynx to the teeth, has been suggested, but although this does conduct the voice, it is of no real practical value.

APPENDIX.

FORMULÆ, ETC.

Othæmatoma, (p. 54).

Injection by means of subcutaneous syringe.

1. ℞ Tr. Iodi, ʒi.
Aquæ, ʒii. M.

Ceruminous Obstructions, (p. 59).

Instillations for softening, all to be used warm.

Water.
Almond oil.

2. ℞ Glycer, ʒii.
Aquæ Rosæ, *ad* ℥i. M.

3. ℞ Liq. Morphiæ, ʒi.
Ol. Amygdalæ, *ad* ℥i. M.

Chronic Localised Dermatitis, (p. 63).

Solutions for painting the denuded surface.

4. Sol. Argent. Nit., xxx. grs. to ℥i.

5. ℞ Ung. Hydrarg. Nit., ʒi.
Ol. Amygdalæ,
Vaseline, āā ℥ss. M.

Circumscribed Inflammation of the Meatus, (p. 71).

Soothing injection.

6. ℞ Liq. Plumbi. Subacet.,
Liq. Morph., āā ʒi.
Aq., *ad* ℥x. M.

One tablespoonful to a wine-glass of warm water.

Ointments—

As Formula No. 5.

7. ℞ Ung. Hydrarg. Fort, ʒi.
Vaseline,
Ol. Amygdalæ, āā ℥ss. M.

Diffuse Inflammation of Meatus,—Acute, (p. 73).

Anodyne instillations (used warm).

8. Aqueous Solution of Morphia, gr. ii. to ʒi.

9. Aqueous Solution of Atropine, gr. i. to ℥i.

Eczema, (p. 75).

Ointments.

10. ℞ Ung. Diachyli, (Hebra),
Ol. Amygdalæ, āā ℥ss. M.

11. ℞ Pulv. Acid. Boracic. gr. xxx.
Vaseline, ℥i. M.

12. ℞ Ung. Zinci. Oxid., ℥i.
Glycerin., ʒii. M.

13. ℞ Pulv. Calomel., ʒi.
Vaseline, ℥i.

Also Formula No. 5.

14. ℞ Ung. Picis,
Vaseline, āā ℥ss. M.

15. ℞ Ol. Rusci, ♏viii.
Vaseline, ℥i. M.

Injections.

16. ℞ Liq. Plumbi Subacet., ℥ss.
Glycerin., ℥iss.
Aq., *ad* ℥viii. M.

One tablespoonful to a wine-glass of warm water.

17. ℞ Zinci. Sulph., ʒss.
Glycerin., ℥iss.
Aq., *ad* ℥viii.

One tablespoonful to a wine-glass of warm water.

18. Saturated solution of Boracic acid to be used with a little hot water.

Syphilitic Inflammation of the Meatus, (p. 79), and Tympanum, (p. 154).

Injection.

19. ℞ Zinci Sulph., gr. xx.
Lot. Nig., ℥x. M.

To be used with an equal proportion of warm water.

Exostosis, (p. 82).

Decalcifying injection.

20. ℞ Acid. Nit. Fort., ʒii.
Aq., ℥viiss.
Misce et adde
Glycerin. Acid. Carbol., ℥ss. M.

To be used with twice the quantity of warm water. (A bone or metal syringe must not be used).

Chronic Non-Suppurative Catarrh, (p. 97).

Nasal injections.

21. As much table-salt as will lie (piled up) on a shilling to a wine-glass of warm water.

22. ℞ Pulv. Ammon. Chlor., ʒss.
Pulv. Sacchar. Alb., ʒii. M.

A teaspoonful to a wine-glass of warm water.

23. ℞ Pulv. Pot. Chlorat., ʒss.
Pulv. Sacchar. Alb., ʒii. M.

A teaspoonful to a wine-glass of warm water.

24. ℞ Glycerin. Boracis.

A teaspoonful to a wine-glass of warm water.

25. ℞ Pulv. Sodæ Bicarb.

As much as will lie on a shilling in a wine-glass of warm water.

26. ℞ Glycerin. Acid. Tannici, ʒiii.
Aq., *ad* ℥iii. M.

A teaspoonful to a wine-glass of warm water.

Gargles.

27. ℞ Pulv. Pot. Chlorat., ʒss.
Glycerin. Boracis, ℥iss.
Aq., *ad* ℥x. M.

28. ℞ Aluminis, ʒi.
Glycerin. Boracis, ℥iss.
Aq., *ad* ℥x. M.

29. ℞ Aluminis, ℈ii.
Glycerin. Acid. Tannici, ℥ss.
Aq., *ad* ℥x. M.

PAINTS, (p. 97).

30. Glycerin. Acid. Tannici.

31. ℞ Liq. Ferri Perchlor. Fort.,
Glycerin., āā ℥i. M.

32. Sol. Argent. Nit., gr. xxv. to ℥i.

33. Sol. Acid. Chrom., 5 *per cent.* to 10 *per cent.*

INHALATIONS, (p. 99).

Fumes of Chloride of Ammonium from—
a. Kerr's Inhaler. *b.* Hawksley's Inhaler.

Solutions for *a.*

34. Liq. Ammon. P.B., on the sponge.
Acid. Hydrochlor. Fort., on the pumice stone.

Ingredients for *b.*

35. Ammon. Carb. (small pieces), in the tube.
Acid. Hydrochlor. Fort., on the pumice stone.

Iodine and Ether vapour.

36. ℞ Tinct. Iodi., ℥iss.
Æther Sulph., ℥ss. M.

Forty minims with ½ pint of boiling water in an earthenware inhaler.

37. ℞ Tinct. Benzoin Co., ʒii.

With ½ pint of boiling water in an earthenware inhaler.

38. Iodide of Ethyl.

10 Minims in a Politzer's bag; to be used as soon as volatilised.

Fluids introduced into the Tympanum.

39. Sol. Sodæ Bicarb., gr. x. to ℥i.

40. Sol. Potass. Iod., gr. v. to ℥i.

These solutions must be used warm.

Internal Remedy.

41. ℞ Pot. Iod., ʒss.
Spt. Ammon. Arom.,
Tr. Gentian. Co., āā ℥i. M.

A teaspoonful in a wine-glass of hot water to be taken twice a day after meals.

Chronic Suppurative Catarrh, (p. 117).

Injections.

42. ℞ Liq. Plumbi. Subacet.,
Glycerin. Acid. Carbol., āā ℥ss.
Aq., ℥x. M.

43. ℞ Zinci Sulph., ʒi.
Glycerin. Acid. Carbol., ℥ss.
Aq., ℥x. M.

Nos. 42 and 43.—A tablespoonful to a wine-glass of warm water.

44. Sol. (saturated) Acid. Boracic., ℥ii.

To be used with enough hot water as will make it pleasantly warm.

45. Boro-glyceride (Barff's).

A teaspoonful in a wine-glass of warm water.

46. ℞ Glycerin. Acid. Carbol., ℥ss.
Spt. Vini Rect., ℥x. M.

A tablespoonful to a wine-glass of warm water.

Instillations.

47. Liq. Plumbi Subacet.

To be used with an equal proportion of warm water.

48. Sol. Argent. Nit., gr. x.—xx. to ℥i.

49. Alcohol (Spt. Vini Rect.).

To be used with two or three times the quantity of warm water at first, rapidly (if the ear tolerates it) increasing the alcohol until it is used pure.

50. ℞ Pulv. Acid. Bor., ʒiss.
Spt. Vini Rect., ℥iii. M.

Directions as No. 49.

51. Peroxide of Hydrogen (10 vols.).

Two or three drops introduced from warm spoon, or on a cotton-wool mop. The oxygen being set free it mechanically cleanses out any suppurating cavity. (Drs. Wilson and Dayton, New York).

Powders (to be blown in by means of quill, see p. 120).

52. Pulv. Cretæ Gall.

53. Pulv. Acid. Tannici.

54. Pulv. Acid. Boracic.

Passed through a silk sieve.

For the Absorbent treatment.

55. Absorbent Cotton Wool.

56. Boracic Acid Cotton Wool.

Granulations and Polypi, (p. 132).

Caustics, etc.

57. P. Argent. Nit.

Fused on end of probe (see p. 132).

58. Sol. Argent. Nit., ʒss—ʒi. to ℥i.

Applied by means of a cotton-wool mop.

59. Acid. Chloro-Acetic.

60. Acid. Chromic.

In crystals, (see p. 133).

61. Iodiform in powder.

Astringents, etc.

62. Pulv. Aluminis Exsiccat.

Blown in, (see p. 120).

63. Pulv. Plumbi Acet.

64. Pulv. Acid. Tannici.

65. Spt. Vini Rect.

As instillation, (see Formula 49).

66. ℞ Tinct. Ferri Perchlor., ℥i.
Spt. Vini Rect., ℥ii. M.

As instillation.

67. Ferri Perchlor. (anhydrous).

Applied on cotton mop.

68. Saturated Solution of Perchloride of Iron in Glycerine.

Applied on cotton mop.

Caries and Necrosis, Mastoiditis, Etc., (pp. 139, 149).

Decalcifying injection as F. 20.

Counter-irritants.

69. Blisters.

70. Linimentum Iodi.

71. ℞ Liq. Epispastici, ʒi.
Tr. Iodi, ℥i. M.

72. Mustard Leaves.

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